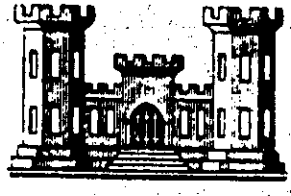
FALL RIVER HARBOR

MASSACHUSETTS AND RHODE ISLAND

IMPROVEMENT DREDGING

DESIGN MEMORANDUM



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

21 AUGUST 1972

46

NEDED-T (21 Aug 72) 2nd Ind
SUBJECT: Design Memorandum on Improvement Dredging, Fall River Harbor, Massachusetts and Rhode Island

DA, New England Division, CE, Waltham, Mass. 02154 16 March 1973

TO: HQDA (DAEN-CWE-B) WASH DC 20314

1. The following is in reply to comments outlined in the preceding 1st Ind:

a. Comment 1. Final environmental statement is being revised in accordance with latest data currently available and will be forwarded to CEQ by the end of the month.

b. Comment 2. Revised paragraphs 9, 10, 11 and 12 are submitted in compliance with the request for a succinct discussion of coordination activities with Federal, State, and local interests.

c. Comment 3. Full discussion and justification for retention of the 3-1/4 percent interest rate is contained in paragraph 47b submitted herewith.

2. Submitted herewith are printed copies of the 1st and 2nd Indorsements and revised Index, and pages 3, 4, 4a(new), 5, 21, 21a(new) and 22. The printed indorsements and revised pages should be substituted in the copies now in your possession.

FOR THE DIVISION ENGINEER:

JOHN Wm. LESLIE
Chief, Engineering Division

1 Incl
wd incl 1
Added 1 incl
2. as

DAEN-CWE-B (NEDED-T, 21 Aug 72) 1st Ind
SUBJECT: Design Memorandum on Improvement Dredging, Fall River Harbor, Massachusetts and Rhode Island

DA, Office of the Chief of Engineers, Washington, D.C. 20314 4 December 1972

TO: Division Engineer, New England, ATTN: NEDED-T

1. Approved, subject to notification that the final environmental statement has been filed with the Council on Environmental Quality and to the comments furnished in the following paragraphs.

2. The subject design memorandum should contain a succinct discussion on coordination activities with Federal, State, and local interests.

3. Paragraphs 9 and 47. Inasmuch as the project was partially budgeted and funded for construction after 31 December 1969 and due to the fact that assurances of local cooperation have not been received, the propriety of using an interest rate of 3-1/4 percent is questioned (see EC 1105-2-201, paragraph 7). A discussion on this issue should be furnished for clarification.

FOR THE CHIEF OF ENGINEERS:

1 Incl
wd

JOSEPH M. CALDWELL
Chief, Engineering Division
Directorate of Civil Works

TABLE OF CONTENTS

R 1/22/73

Act of 1968, as described in paragraph 3. The project modification was authorized subject to the requirements that prior to construction local interests agreed to:

a. Provide without cost to the United States all lands, easements, and rights-of-way required for construction and subsequent maintenance of the project and for aids to navigation upon request of the Chief of Engineers;

b. Hold and save the United States free from damages due to construction and maintenance of the project;

c. Provide and maintain without cost to the United States adequate depths in approach channels and berthing areas serving the terminals commensurate with depths provided in the related project areas;

d. Accomplish without cost to the United States such utility and other relocations or alterations as necessary for project pruposes;

e. Demolish and remove Slades Ferry Bridge at local expense;

f. Assume construction costs in accordance with the principles of Section 6 of the Bridge Alteration Act of 21 June 1940, as amended by the Act of 16 July 1962, for altering or reconstructing the Brightman Street Bridge.

9. Status of Local Cooperation. The Commonwealth of Massachusetts and the State of Rhode Island and Providence Plantations have indicated by letters of 4 March 1969 and 29 October 1969, respectively, that assurances of local cooperation will be provided at the proper time. Formal request for these assurances was issued on 28 April 1971. Formal request for assurances from the Commonwealth of Massachusetts and the State of Rhode Island was again issued on 3 March 1972 in accordance with the new procedural requirement for obtaining local cooperation agreements under Section 221 of the Flood Control Act of 1970, Public Law 91-610, 91st Congress, 2nd Session. Although no formal replies have as yet been received from either State, the Commonwealth of Massachusetts has expended the sum of $400,000 to demolish and remove the Slades Ferry Bridge (Paragraph 8e above). The Commissioner, Massachusetts Department of Public Works signed an agreement with the Division Engineer on 29 December 1966 that established the cost apportionment for the Brightman Street Bridge alterations utilizing the principles of the Truman-Hobbs Act and has recently awarded a design contract for a new Brightman Street Bridge. It is currently estimated that the cost to local interests will be $782,000 for the relocation or alteration of the Brightman Street Bridge, and $1,318,000 for berth and approach channel improvements.

10. Coordination with Federal, State, and Local Interests, Prior to Authorization. All necessary coordination with Federal, State and local interests leading to the authorization of the project on 13 August 1968 has been accomplished. Originally, the specific items of local need for navigation improvement were presented at a public hearing held in Fall River, Massachusetts on 22 June 1961. Attendance at this meeting reflected the concern of all interests who have any direct use of the Fall River-Tiverton waterways. Representatives of the Federal, States and municipal governments, shipping interests, power companies, terminal interests, and local citizens all were present. Their proposals included; deepening both the "Bay" and "Tiverton" channels to 40 or 45 feet; widen both channels to 500 feet; widen bend leading into the channel along the north Tiverton waterfront; provide a turning and maneuvering basin at the north end of the Tiverton waterfront; alter the existing Taunton River channel spans of both bridges to provide wider horizontal clearances in both spans. In lieu of altering bridges, one company requested a 40-foot depth to a line 1,200 feet below Slades Ferry Bridge and a suitable turning and maneuvering basin in that area. All of these improvements were considered necessary because of the increasing size of the tankers, colliers, and cargo vessels using the facilities.

Subsequent discussions, during the preparation of the Survey Report and development of the authorized plans for modification of the existing Fall River project, were held with representatives of the Commonwealth of Massachusetts, State of Rhode Island, City of Fall River, the Town of Tiverton, R. I., the Town of Somerset, New England Power Company, the Montaup Electric Company, and the various terminal and shipping interests. Conferences were held with representatives of the Massachusetts Department of Public Works, who furnished bridge alteration estimates. The U.S. Fish and Wildlife Service was consulted on the possible adverse effect on marine life of spoil from the project dumped at sea.

11. Coordination with Federal, State and Local Interests, After Authorization. Most of the coordination with the various Federal, State and local interests subsequent to authorization concerned scheduling and location of an acceptable disposal area. Upon enactment of the National Environmental Policy Act of 1969 (PL 90-190), 1 January 1970, preparation of the Environmental Statement shifted the coordination emphasis from the commercial dollar benefits for the project to the environmental effect of the project, not only to the immediate area of the dredging but also to any area selected for disposal of the dredged materials. The Final Environmental Statement, which includes the comments of all the Federal, State and local interests concerned, has been completed and is being reviewed by various elements of the New England Division staff. Of the more than fifteen individual replies to the draft of the Environmental Statement, approximately 31 percent were favorable, 19 percent unfavorable, and 50 percent would accept the project as proposed if certain conditions could be met.

12. Local Interest Indorsements. All of the concerned local interests have indorsed the authorized modification for improvement dredging in Fall River Harbor, Massachusetts and Rhode Island. The Mayor of Fall River is on record that the city cannot withstand the adverse economic impact which would result from any delay in the implementation of this project. The mayor also called the project vitally important to our economic future. The American Merchant Marine Institute has stated that the 40-foot channel depths are greatly needed to more adequately accommodate tankers and other vessels of larger dimensions and deeper drafts now in operation and coming into service. The Commonwealth of Massachusetts is actively supporting the project. They have already demolished and removed the Slades Ferry Bridge and have awarded a contract for design and plans and specifications for a new bridge to replace the Brightman Street Bridge as a part of the interchange between U.S. Route 6, Route 138 and The Fall River Western Expressway.

13. Local Interest Plan for Part Dredged Material. In February 1969 at a joint meeting of the Corps of Engineers and the Commonwealth of Massachusetts Division of Waterways it was decided to prepare a feasibility study funded by the City of Fall River for the Battleship Massachusetts Cove waterfront area. This proposal which included diking and build-up of about 40 acres of the waterfront would utilize approximately 1 to 2 million cubic yards of fill from the Federal dredging project was indorsed by the Mayor and City Council of Fall River, the Fall River Planning Board, Industrial Commission, Port Authority, Chamber of Commerce, Board of Realtors, and also the Southeastern Regional Planning and Economic Development District, the Battleship Massachusetts organization, and the Marine Museum at Fall River. The redevelopment of this 40-acre "Battleship Cove" area would not only provide impetus toward elevating Fall River from its present depressed area status but would save the Federal project considerable funds by providing a local disposal area for about one quarter to one half of the materials to be dredged. On 2 April 1970, the City Council of Fall River adopted a resolution committing the City to a 50 percent share of constructing a dike or bulkhead to form Battleship Cove. The results of an extensive subaqueous sampling program indicating that dredged material from the Federal deepening project would be totally unsuitable for land fill were given local authorities at a meeting on 18 September 1970. The Commonwealth of Massachusetts, Department of Public Works, Division of Waterways believing that suitable land fill material for the Battleship Cove Project could be found within a reasonable distance instigated a survey to ascertain its location. To date no area containing sufficient quantity of usable materials has been reported.

14. Fall River Unemployment Percentage. The Fall River, Massachusetts-Tiverton, Rhode Island area now has one of the highest unemployment percentages in the country. The local authorities consider that early completion of the Federal Channel Project permitting increasing use of the waterfront facilities for delivery and export of merchandise is essential to reversal of this escalating unemployment percentage.

15. Fuel Requirements, Electric Companies. Fuel for the Montaup Electric Company, the New England Power Company, and the Fall River Electric Light Company, is delivered via the Federal channels. These power companies not only supply energy to the immediate project area but are integral units in the power grid for the whole region of southeastern Massachusetts and eastern Rhode Island. All power generating units have now been converted to oil and are experiencing difficulty in finding suppliers with tankers that can negotiate the 35-foot channels and the restrictive bridge. Power demands are increasing rapidly in the area. The Federal Power Commission forecast indicates that an additional 1,000,000 kw capacity over and above the present capacity will be needed in the near future and certainly within the project lifetime. Both Montaup and New England Power have indicated site capacity for future expansion; however, actual construction will depend upon availability of fuel at a reasonable cost.

16. Location and Tributary Area. Fall River Harbor is located at the head of Mount Hope Bay, an easterly arm of Narragansett Bay, and in the lower portion of the Taunton River. The major part of the project lies in the municipalities of Fall River and Somerset, Massachusetts, the remainder in the Town of Tiverton , Rhode Island. The harbor itself is about 50 miles from Boston, Massachusetts, 20 miles from Providence, Rhode Island and 22 miles from the entrance to Narragansett Bay.

17. Fall River Harbor, situated as it is between the two deep-draft harbors of Providence, Rhode Island and New Bedford, Massachusetts, would appear to have a somewhat limited tributary area. The true tributary area is not an arbitrary circle but is considered to consist of an irregularly shaped area, all parts extending from Fall River. Within this entire area there is a population of about 1,169,000 persons. The needs of this overall region are served in part by each of several ports; namely, Fall River, New Bedford, Providence and Boston. The major cause for the overlapping characteristics of the tributary areas of these ports is the existence of two 6-inch pipes for the distribution of domestic fuels. The pipe lines are owned by the Shell Oil Company and emanate from their facilities located at the head of the project. One of the pipelines terminates in a tank farm at West Boylston, just north of Worcester, Massachusetts. This tank farm serves a large portion of central Massachusetts and parts of southern Vermont and New Hampshire. The second pipeline runs to Waltham, Massachusetts where it serves much of Metropolitan Boston. Approximately 60 percent of the total waterborne petroleum receipts of the Shell Oil Company are handled annually by these pipe lines.

18. The immediate tributary area encompasses the cities of Fall River and Taunton. Both are highly industrialized communities, counting among their manufactures cotton goods, gas ranges, rubber, brass, bronze and silver products. These industries require large amounts of electric power, most of which is generated in conventional fossil fuel plants contiguous to the project. The distribution area of these power plants extends over a significant part of southeastern Massachusetts and eastern Rhode Island. Fuel is delivered in deep draft tankers from South American and foreign ports.

19. Immediately south of Fall River lies Tiverton, Rhode Island. Tiverton is essentially a residential town; however, four tank farms are located within its corporate limits.

20. The area is served by the Penn Central Transportation Company (formerly the New York, New Haven and Hartford Railroad) and a system of modern highways supplemented by a network of excellent secondary roads.

46. Operation and Maintenance. Maintenance of the project is a Federal function and will consist of periodic dredging to restore project depths within the limits of the Federal project. The estimated additional annual maintenance quantities are based primarily on shoaling experienced in the existing channels adjusted for the greater project depths and for widening bend leading into Tiverton upper channel to 600 feet. The additional annual maintenance cost is estimated as $48,000. This is based on an additional total shoaling of 18,000 cubic yards per year, 14,500 cubic yards in Mt. Hope Bay-Fall River Harbor Channel (below bridge including Tiverton Channel (Contract 1) and 3,500 cubic yards per year in the Fall River Channel and Turning Basin (above bridge) Contract 2)). Estimate for Contract 1 is $39,000 and for Contract 2 $9,000.

47. a. Benefits. The benefit analysis is based on a 50-year project life at 3-1/4 percent interest rate. The benefits are considered general in nature and are expected to accrue from the same sources as stated in the Review Report. Current benefits are based on a re-analysis of those in the authorizing document to reflect current price levels, refined commerce projections based on the latest available statistics, on a reduction in projected population growth, and a reduction in the projected fuel needs of the Montaup Electric Company due to cutting of the planned future power plant from about 1.5 million kw to 600,000 kw. It is known that at least two oil companies are negotiating for a location in the Fall River-Tiverton area to construct a multi-million dollar refinery and chemical plant, another company has a 35-acre site in Fall River upon which they want to construct a multi-million dollar "Energy Center", and an Architect-Engineer firm is investigating possibilities of setting up an "overseas" auto terminal in the vicinity of Borden's Wharf in Tiverton. No benefits have been assigned for the possible future construction of these projects. If any one of the projects were built within the 50-year life of the Fall River Harbor improvement project, it would add substantially to the benefits "below the bridge".

b. Justification for Retention of Interest Rate. On 24 December 1968 a new formula, originally proposed by the Water Resources Council, for computing the discount rate to be used in plan formulation for discounting future benefits and computing costs, became effective. Included in the formula was a proviso that the old rate ---3-1/4 percent --- will be used for authorized projects if non-Federal financial commitments were made by December 31, 1969. By letter dated 3 February 1969, ENGCW-B/ENGCW-RL, Subject: "Application of New Discount Rate Procedure to Authorized Projects", the Office, Chief of Engineers indicated that if local interests provided, prior to 31 December 1969, adequate expression of assurance that the requirements of local cooperation would be met, the applicable discount rate would remain at 3-1/4 percent.

By letter dated 20 November 1969 the New England Division informed the Chief of Engineers that acceptable letters of intent had been received from the Commonwealth of Massachusetts and the State of Rhode Island. Both States were notified that the letters were sufficient to retain the 3-1/4 percent interest rate. Attached to New England Division's letter of 13 January 1970 was a tabulation showing all NED projects that retained prior interest rate (3-1/4 percent). Included in this tabulation was the Fall River Harbor channel improvement project.

In addition, Engineering Circular 1105-2-201, paragraph 7; states in part, "Projects which have already received an appropriation of construction funds in Fiscal Year 1973 may continue to use the interest rates that were used to prepare the supporting economic data presented to Congress in justification of the initial appropriation of construction funds in making any subsequent evaluations, cost allocation studies and cost sharing determinations until construction of the project is completed." This criteria was also in effect for prior budget years. Initial funds for the Fall River Harbor project were appropriated, as a capability start, in Fiscal Year 1971. The economics used in the justification data reported to Congress in support of the F.Y. 1971 budget was based on a 3-1/4 percent interest rate. Accordingly, the 3-1/4 percent rate would also be retained under this criteria.

48. Improvement of the waterways will result in important benefits, not only for the immediate locality but also for an irregularly shaped area extending outward from Fall River as far as Worcester and Boston, Massachusetts, containing about 1,189,000 people. The benefits result from more economical transportation of the various items which will comprise the future waterborne commerce. Transportation savings will be realized in four general areas; namely, elimination of restrictive bridges, the use of larger and deeper draft vessels, and the reduction in required annual towboat costs.

49. The benefits have been divided into four general categories. These are general growth, existing power plants, (all of the electric units listed in the authorizing document as coal fired have now been converted to oil) new power plants and new units in existing plants, and towboat hire. Benefits in the above categories were computed for the Fall River Harbor and Tiverton Channels. In addition, the benefits for the Fall River Harbor channel were separated into those benefits attributable

to the channel below the bridge, above the bridge, and to removal of the bridge. The general growth category is the increase in petroleum and petroleum products expected to occur over the project life due to population growth, new and more varied uses of petroleum products and increases in use of fuel oil for industrial purposes and domestic heating. These petroleum deliveries are expected to increase from 2,400,000 tons to 5,100,000 tons annually during the life of the project. It is assumed that this oil will be carried by U. S. Tankers (domestic) and one half of the benefits will be allocated to the port of origin. During the project life period of 50 years, larger tankers can be used resulting in significant savings.

All the oil deliveries to the existing electrical power units and to the new power plants are expected to be carried in foreign vessels, full benefits will accrue from the increase from 1,800,000 tons to 3,000,000 tons annually during the life of the project.

The existing Power Plant benefit category is the shipping savings which would accrue to oil tanker deliveries to existing power plants on the channels.

The new Power Plants and Units category is the shipping savings which would develop from use of the larger oil tankers for delivery of oil for the additional electric capacity expected to be installed in the Montaup Electric Company plant above the bridges and to a 600,000 kw plant to be erected on the Montaup Electric Company's site below the bridges. The New England Power Company expects to complete a 450,000 kw addition to its Brayton Point plant in 1973. The increased oil deliveries required for the new power units and the new plant to be constructed amounts to 760,000 tons of oil annualy based on the same oil to kw ratio as indicated in the Review Report. The towboat hire benefit is derived from the reduction in the number of vessel trips due to use of larger capacity tankers. The benefits obtained from the elimination of tidal delays to present and future commerce has been included in benefits computed for the other items.

50. The Office, Chief of Engineers by teletype dated 17 September 1971, issued instructions that dredging of the channel above the Brightman Street Bridge be deferred until the Commonwealth of Massachusetts completes the new bridge. The work on the channel above the bridge will be coordinated with the removal of the existing bridge. Based on information from the State, it is estimated that the channel above the

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

IN REPLY REFER TO

21 August 1972

NEDED-T

SUBJECT: Design Memorandum on Improvement Dredging, Fall River Harbor, Massachusetts and Rhode Island

HQDA (DAEN-CWE-B)
WASH DC 20314

1. Submitted herewith in accordance with ER 1110-2-1150 are fourteen (14) copies of the subject design memorandum for review and approval.

2. Draft of the Environmental Statement for this project was placed on file with C. E. Q. 2 December 1971. Final statement will be forwarded C. E. Q. this fall.

FOR THE DIVISION ENGINEER:

Meyer S Slotkin
for JOHN Wm. LESLIE
Chief, Engineering Division

1 Incl (14 cys)
as

DESIGN MEMORANDUM
ON
IMPROVEMENT DREDGING
FALL RIVER HARBOR
MASSACHUSETTS AND RHODE ISLAND

PERTINENT DATA

1. Purpose. To review the project modifications, prepare a final plan of improvement, and make an up-to-date estimate of project cost based on more recent field surveys and on work accomplished, in progress or planned by local authorities.

2. Location. Fall River Harbor lies in Mt. Hope Bay, an arm of Narragansett Bay. The area includes portions of the east coast of Rhode Island and the southeastern shore of Massachusetts. It is about 50 miles from Boston, Massachusetts, and 22 miles from the entrance to Narragansett Bay. The main ship channel extends from deep water in Mt. Hope Bay for a distance of about 7.4 miles northeastward terminating in the Taunton River. A second deep-draft channel extends eastward from deep water in Mt. Hope Bay to the Rhode Island shore, thence north and south along the shore of Tiverton, Rhode Island. Mean tide range is 4.4 feet.

3. Project Authorization. River and Harbor Act of 3 July 1930 and as modified by the River and Harbor Acts of 1946, 1954 and 1968.

4. Project Document. House Document No. 175, 90th Congress, 1st Session, October 1967.

5. Recommended Project Plan.

a. Deepening existing 400-foot wide by 35-foot deep Mt. Hope Bay Channel to 40 feet within the existing channel limits, from deep water in Mt. Hope Bay to and including the existing turning basin, upriver of the bridges.

b. Deepening existing 400-foot wide, 35-foot deep Tiverton Channel to 40 feet to the vicinity of the Tiverton shore, thence upstream to vicinity of the Gulf Oil Terminal, and widening the bend leading to this upper channel to 600 feet.

c. Providing a channel 400 feet wide and 40 feet deep along the waterfront in Tiverton Lower Pool to the vicinity of the Northeast Petroleum Corporation.

d. Altering Brightman Street Bridge to provide for a clear channel width of 300 feet through the drawspan. (Principles of Truman-Hobbs Act)

e. Removal of the Slades Ferry Bridge by the Commonwealth of Massachusetts. (Completed 1971)

6. Estimated First Cost of Construction - 40' Channel (1972 Base)

Federal Costs	In 1,000
Reloc. (Bridge Alt.)	5,295.0
Channels 40 Ft.	13,780.0
E & D	410.0
S & A	630.0
Total Fed Cost	$20,000.0
Non-Fed Costs	
Reloc (Bridge Alt.)	782.0
Bridge Removal	400.0
Other (Berth Imp)	1,318.0
Total Non-Fed	$ 2,500.0
Total Fed & Non-Fed	$22,500.0

7. Benefits.

Transport Savings	
(Oil)	2,798.0
Reduction in Tow Charges	35.0
Annual Total Benefit	$ 2,833.0

8. Annual Charges.

Int. & Amort. Federal	862.0
Add. Ann. Maint. Non-Fed	34.0
Annual Total Charges	$ 896.0

9. Benefit-Cost Ratio.

$$\frac{\text{Total Ann. Benefit}}{\text{Total Ann. Charges}} \quad \frac{2,833}{896} = 3.2/1$$

10. Requirements of Local Cooperation.

a. Provide without cost to the U. S. all lands, easements and rights-of-way necessary for construction and maintenance of the project and for aids to navigation upon request of the Chief of Engineers.

b. Hold and save the U. S. free from damages due to construction of the project.

c. Improve berths and access channels to a depth commensurate with project depth.

d. Make such alterations to underwater utilities as necessary to enable full realization of the project benefits.

e. Demolish and remove the existing Slades Ferry Bridge (completed 1971).

f. Alter or reconstruct Brightman Street Bridge assuming a share of costs in accordance with principles of the Truman-Hobbs Act.

TABLE OF CONTENTS

IMPROVEMENT DREDGING
FALL RIVER HARBOR
MASSACHUSETTS AND RHODE ISLAND

PROJECT AUTHORIZATION

1. The existing project for Fall River Harbor, Massachusetts and Rhode Island was adopted 3 July 1930 and modified by the River and Harbor Acts of 24 July 1946 and 3 September 1954. The existing project provides for a channel 35 feet deep and 400 feet wide, extending from deep water in Mount Hope Bay to the Globe Wharf at the mouth of the Taunton River. The channel continues at the same dimensions, increasing in width at the bends upstream to the Shell and Montaup wharves above the Brightman Street Bridge. A turning basin 35 feet deep, 1,100 feet wide and 950 feet long is provided at the upstream limit of the project. The existing project also provides for a separate channel 35 feet deep and 400 feet wide extending from deep water in Mount Hope Bay easterly to the vicinity of the Tiverton Shore from where it branches northerly and southerly along the Tiverton waterfront. The northerly limit is about opposite the Gulf Oil Company wharf and the southerly limit is deep water in Tiverton Lower Pool. Other provisions of the existing project include the removal of ledge at the lower end of Hog Island Shoal to a depth of 30 feet; maintenance of a 25-foot anchorage west of the upper harbor channel; and for a channel 30 feet deep east of the main harbor channel in the area from the vicinity of the State Pier to just below Slades Ferry Bridge.

2. The existing project, except for that portion calling for the removal of rock at the Hog Island Shoal, was completed in March 1959. Total costs of new work to date since the initial work in 1874 have been $4,438,204 and $804,236 for maintenance. The project was last maintained in fiscal year 1963 at a cost of $465,668. The average annual maintenance cost over the last five fiscal years has been $96,426 and in the last ten fiscal years has been $48,985.

3. The presently uncompleted modification for improvement dredging in Fall River Harbor, Massachusetts and Rhode Island was authorized by the River and Harbor Act of 13 August 1968 (P.L. 90-483). The project as authorized, modifies the existing project in accordance with the recommendations set forth in House Document 175, 90th Congress, 1st Session and provides for:

a. Deepening the existing 400-foot wide 35-foot deep Mount Hope Bay Channel to 40 feet within the existing channel limits from deep water in Mount Hope Bay to and including the existing turning basin upriver of the bridges.

b. Deepening the existing 400-foot wide by 35-foot deep Tiverton Channel to a depth of 40 feet to the vicinity of the Tiverton shore, thence upstream to the vicinity of the Gulf Oil Terminal and widening the bend leading into this channel to 600 feet.

c. A channel 400 feet wide and 40 feet deep in Tiverton Lower Pool along the Tiverton waterfront to the vicinity of the Northeast Petroleum Corporation.

d. Altering the Brightman Street Bridge to provide for a clear channel width of 300 feet through the drawspan.

All generally in accordance with the plan of the Division Engineer and with such modifications thereof as in the discretion of the Chief of Engineers may be advisable.

4. Investigations. Physical investigations carried out in support of the survey report contained in House Document No. 175, 90th Congress, 1st Session, were made in 1950, 1958, 1962 and 1963. The investigations consisted of hydrographic, boring and probing surveys. Topography was taken from previous surveys and from U.S.C. & G.S. Chart No. 350.

5. Subsequent to the Authorizing Document, the channels have been thoroughly investigated by taking 138 machine probes, 115 piston core samples and 27 drive sample borings in 1969 and 1970. Most of the material is highly organic silt which is totally unsuitable for use as land fill.

6. Environmental sampling within the area to be dredged consisted of 131 piston cores. Additional sampling, for comparison with materials excavated from the Providence River project and for chemical analysis, included 10 pressed piston tubes and 11 grab samples in the Taunton River upstream from the project area, 16 modified Kullenberg cores in the project area, and four piston cores in the planned disposal ground off Newport, Rhode Island. All samples were taken during the summer and autumn of 1970 and early 1971.

7. Complete sounding of all channel areas at approximately 75-foot spacing was accomplished in 1971 and early 1972.

8. Requirements of Local Cooperation. All provisions of local cooperation, as required by the documents authorizing the existing project and the subsequent modifications up to and including the River and Harbor Act of 1954 have been fully complied with. The improvement discussed in this design memorandum is the work authorized by the River and Harbor

Act of 1968, as described in paragraph 3. The project modification was authorized subject to the requirements that prior to construction local interests agreed to:

a. Provide without cost to the United States all lands, easements, and rights-of-way required for construction and subsequent maintenance of the project and for aids to navigation upon request of the Chief of Engineers;

b. Hold and save the United States free from damages due to construction and maintenance of the project;

c. Provide and maintain without cost to the United States adequate depths in approach channels and berthing areas serving the terminals commensurate with depths provided in the related project areas;

d. Accomplish without cost to the United States such utility and other relocations or alterations as necessary for project purposes;

e. Demolish and remove Slades Ferry Bridge at local expense;

f. Assume construction costs in accordance with the principles of Section 6 of the Bridge Alteration Act of 21 June 1940, as amended by the Act of 16 July 1962, for altering or reconstructing the Brightman Street Bridge.

9. Status of Local Cooperation. The Commonwealth of Massachusetts and the State of Rhode Island and Providence Plantations have indicated by letters of 4 March 1969 and 29 October 1969, respectively, that assurances of local cooperation will be provided at the proper time. Formal request for these assurances was issued on 28 April 1971. Formal request for assurances from the Commonwealth of Massachusetts and the State of Rhode Island was again issued on 3 March 1972 in accordance with the new procedural requirement for obtaining local cooperation agreements under Section 221 of the Flood Control Act of 1970, Public Law 91-610, 91st Congress, 2nd Session. No formal replies have as yet been received. The Commissioner, Massachusetts Department of Public Works signed an agreement with the Division Engineer on 29 December 1966 that established the cost apportionment for the Brightman Street Bridge alterations utilizing the principles of the Truman-Hobbs Act. The Commonwealth of Massachusetts has completed the demolition and removal of the Slades Ferry Bridge at a cost of $400,000 and has awarded a design contract for a new Brightman Street Bridge. It is currently estimated that the cost to local interests will be $782,000 for the relocation or alteration of the Brightman Street Bridge, and $1,318,000 for berth and approach channel improvements.

10. Coordination with Federal, State and local interests has and is still in progress with respect to the project. Originally, the specific items of local need for navigation improvement were presented at a public hearing held in Fall River, Massachusetts on 22 June 1961. Attendance at this meeting reflected the concern of all interests who have any direct use of the Fall River-Tiverton waterways. Representatives of the Federal, States and municipal governments, shipping interests, power companies, terminal interests, and local citizens all were present. Their proposals included: deepening both the "Bay" and "Tiverton" channels to 40 or 45 feet; widen both channels to 500 feet; widen bend leading into the channel along the north Tiverton waterfront; provide a turning and maneuvering basin at the north end of the Tiverton waterfront; alter the existing Taunton River channel spans of both bridges to provide wider horizontal clearances in both spans. In lieu of altering bridges, one company requested a 40-foot depth to a line 1,200 feet below Slades Ferry Bridge and a suitable turning and maneuvering basin in that area. All of these improvements were considered necessary because of the increasing size of the tankers, colliers, and cargo vessels using the facilities.

11. Subsequent discussions, during the preparation of the Survey Report and development of the authorized plan for modification of the existing Fall River project, were held with representatives of the Commonwealth of Massachusetts, State of Rhode Island, City of Fall River, the Town of Tiverton, R. I., the Town of Somerset, New England Power Company, the Montaup Electric Company, and the various terminal and shipping interests. Conferences were held with representatives of the Massachusetts Department of Public Works, who furnished bridge alteration estimates. The U. S. Fish and Wildlife Service was consulted on the possible adverse effect on marine life of spoil from the project dumped at sea.

12. All of the concerned local interests have indorsed the authorized modification for improvement dredging in Fall River Harbor, Massachusetts and Rhode Island. The Mayor of Fall River is on record that the city cannot withstand the adverse economic impact which would result from any delay in the implementation of this project. The mayor also called the project vitally important to our economic future. The American Merchant Marine Institute has stated that the 40-foot channel depths are greatly needed to more adequately accommodate tankers and other vessels of larger dimensions and deeper drafts now in operation and coming into service. The Commonwealth of Massachusetts is actively supporting the project. They have already demolished and removed the Slades Ferry Bridge and have awarded a contract for design and plans and specifications for a new bridge to replace the Brightman Street Bridge as a part of the interchange between U. S. Route 6, State Route 138 and the Fall River Western Expressway.

13. In February 1969 at a joint meeting of the Corps of Engineers and the Commonwealth of Massachusetts Division of Waterways it was decided to prepare a feasibility study funded by the City of Fall River for the Battleship Massachusetts Cove waterfront area. This proposal which included diking and build-up of about 40 acres of the waterfront would utilize approximately 1 to 2 million cubic yards of fill from the Federal dredging project was indorsed by the Mayor and City Council of Fall River, the Fall River Planning Board, Industrial Commission, Port Authority, Chamber of Commerce, Board of Realtors, and also the Southeastern Regional Planning and Economic Development District, the Battleship Massachusetts organization, and the Marine Museum at Fall River. The redevelopment of this 40-acre "Battleship Cove" area would not only provide impetus toward elevating Fall River from its present depressed area status but would save the Federal project considerable funds by providing a local disposal area for about one quarter to one half of the materials to be dredged. On 2 April 1970, the City Council of Fall River adopted a resolution committing the City to a 50 percent share of constructing a dike or bulkhead to form Battleship Cove. The results of an extensive sub-aqueous sampling program indicating that dredged material from the Federal deepening project would be totally unsuitable for land fill were given local authorities at a meeting on 18 September 1970. The commonwealth of Massachusetts, Department of Public Works, Division of Waterways believing that suitable land fill material for the Battleship Cove Project could be found within a reasonable distance instigated a survey to ascertain its location. To date no area containing sufficient quantity of usable materials has been reported.

14. The Fall River, Massachusetts - Tiverton, Rhode Island area now has one of the highest unemployment percentages in the country. The local authorities consider that early completion of the Federal Channel Project permitting increasing use of the waterfront facilities for delivery and export of merchandise is essential to reversal of this escalating unemployment percentage.

15. Fuel for the Montaup Electric Company, the New England Power Company, and the Fall River Electric Light Company, is delivered via the Federal channels. These power companies not only supply energy to the immediate project area but are integral units in the power grid for the whole region of southeastern Massachusetts and eastern Rhode Island. All power generating units have now been converted to oil and are experiencing difficulty in finding suppliers with tankers that can negotiate the 35-foot channels and the restrictive bridge. Power demands are increasing rapidly in the area. The Federal Power Commission forecast indicates that an additional 1,000,000 kw capacity over and above the present capacity will be needed in the near future and certainly within the project lifetime. Both Montaup and New England Power have indicated site capacity for future expansion; however, actual construction will depend upon availability of fuel at a reasonable cost.

16. Location and Tributary Area. Fall River Harbor is located at the head of Mount Hope Bay, an easterly arm of Narragansett Bay, and in the lower portion of the Taunton River. The major part of the project lies in the municipalities of Fall River and Somerset, Massachusetts, the remainder in the Town of Tiverton , Rhode Island. The harbor itself is about 50 miles from Boston, Massachusetts, 20 miles from Providence, Rhode Island and 22 miles from the entrance to Narragansett Bay.

17. Fall River Harbor, situated as it is between the two deep-draft harbors of Providence, Rhode Island and New Bedford, Massachusetts, would appear to have a somewhat limited tributary area. The true tributary area is not an arbitrary circle but is considered to consist of an irregularly shaped area, all parts extending from Fall River. Within this entire area there is a population of about 1,169,000 persons. The needs of this overall region are served in part by each of several ports; namely, Fall River, New Bedford, Providence and Boston. The major cause for the overlapping characteristics of the tributary areas of these ports is the existence of two 6-inch pipes for the distribution of domestic fuels. The pipe lines are owned by the Shell Oil Company and emanate from their facilities located at the head of the project. One of the pipelines terminates in a tank farm at West Boylston, just north of Worcester, Massachusetts. This tank farm serves a large portion of central Massachusetts and parts of southern Vermont and New Hampshire. The second pipeline runs to Waltham, Massachusetts where it serves much of Metropolitan Boston. Approximately 60 percent of the total waterborne petroleum receipts of the Shell Oil Company are handled annually by these pipe lines.

18. The immediate tributary area encompasses the cities of Fall River and Taunton. Both are highly industrialized communities, counting among their manufactures cotton goods, gas ranges, rubber, brass, bronze and silver products. These industries require large amounts of electric power, most of which is generated in conventional fossil fuel plants contiguous to the project. The distribution area of these power plants extends over a significant part of southeastern Massachusetts and eastern Rhode Island. Fuel is delivered in deep draft tankers from South American and foreign ports.

19. Immediately south of Fall River lies Tiverton, Rhode Island. Tiverton is essentially a residential town; however, four tank farms are located within its corporate limits.

20. The area is served by the Penn Central Transportation Company (formerly the New York, New Haven and Hartford Railroad) and a system of modern highways supplemented by a network of excellent secondary roads.

21. The most used approach to Fall River Harbor from the Atlantic Ocean is into Rhode Island Sound, thence through the East Passage of Narragansett Bay and Mount Hope Bay. The recently completed Newport Bridge, a high level suspension bridge, crosses the East Passage from Newport to Jamestown. It has a clear horizontal span of 1,500 feet and a vertical clearance of 195 feet at m.h.w. A high level suspension bridge completed in 1929, spans the entrance to Mount Hope Bay. It has a horizontal clearance of 1,156 feet between channel piers, and has a vertical clearance of 135 feet at m.h.w. for a channel width of 400 feet. The Braga Bridge, completed in 1966, crosses Fall River Harbor at the mouth of the Taunton River. This high level bridge has a central cantilever span of 940 feet between piers and a vertical clearance of 135 feet at m.h.w. for the channel width of 400 feet. In the Taunton River section of Fall River Harbor there were two existing drawbridges. The Slades Ferry Bridge and the channel abutments have been removed by the Commonwealth of Massachusetts (accepted March 1971). The Massachusetts Department of Public Works is now planning the removal and relocation of the Brightman Street Bridge. In the Sakonnet River, lesser used alternative entrance to Mount Hope Bay and direct entrance to the Tiverton channel portion of the project, there are two bridges. Going upstream from Rhode Island Sound, the first is a fixed highway bridge with a vertical clearance of 65 feet at m.h.w. for the channel width of 172 feet. The second is a swing railroad bridge having a vertical clearance of 12 feet at m.h.w. in the closed position and a horizontal channel clearance of 99 feet.

22. Project Plan. The project plan contemplates that the existing navigation project for Fall River Harbor, Massachusetts and Rhode Island will be modified to provide for:

a. Deepening the existing 400-foot wide by 35-foot deep Mount Hope Bay channel to 40 feet within the existing channel limits from deep water in Mount Hope Bay to and including the existing turning basin upriver of the bridges;

b. Deepening the existing 400-foot wide by 35-foot deep Tiverton channel to a depth of 40 feet to the vicinity of the Tiverton shore, thence upstream to the vicinity of the Gulf Oil terminal and widening the bend leading into this channel to 600 feet;

c. A channel 400 feet wide and 40 feet deep in Tiverton Lower Pool along the Tiverton waterfront to the vicinity of the Northeast Petroleum Corporation terminal;

d. Altering the Brightman Street Bridge to provide for a clear channel width of 300 feet through the drawspan;

e. Removal of the Slades Ferry Bridge by the Commonwealth of Massachusetts (completed 1971).

23. In order to provide a clear channel depth of 40 feet in the channels, the project plan involves the dredging of about 4,550,000 cubic yards (not including 250,000 cubic yards maintenance dredging of the 35 foot channel) of ordinary materials to a depth of 40 feet plus 2 feet of allowable overdepth. The 2-foot allowable overdepth provides for inaccuracies in the dredging process at the specified depth and insures attainment of project depth.

24. Character of Materials. The channels have been thoroughly explored to determine the materials to be encountered and for environmental purposes by taking 115 piston core samples and 27 drive sample borings. Approximately 80 percent of the materials consists of highly organic silt which is unsuitable for land fill. The remaining 20 percent is sand, gravel and inorganic silt which, if separated from the organic silt, would be permissible for use as land fill with proper controls. The suitable material, unfortunately, exists in patches and layers closely associated with, and therefore inseparable from, the unsuitable material. Core samples and environmental sampling and testing results are discussed and tabulated in Appendix B.

In addition to the above sampling, 232 probings were made to determine the presence or absence of hard materials. Most of the material is soft and is expected to be easy digging. A narrow area about 4,500 feet long on the northeast side of the existing channel spanning the location of the Brightman Street and the former Slades Ferry Bridges consists at least in part, of highly compact glacial till which would be difficult to excavate. To minimize hard digging and possible rock excavation, the channel alinement has been moved about 30 feet southwest. It is possible that minor quantities of glacial till and possible rock hits still may be encountered.

Previous dredging projects have encountered boulders in an area along the south branch of the Tiverton channel near the east edge and in front of the oil terminals. Locations of probings and drive sample borings and tabulations showing the results of the probings are shown on sheets 2 thru 9 of attached maps. Graphic logs of the drive sample borings are shown on sheet 10.

25. The material could be easily handled by hydraulic dredging.. The City of Fall River Central Waterfront Project (Battleship Cove) sponsored by the Fall River Redevelopment Authority, and Battleship Massachusetts, has indicated that they could use one to two million yards of material from the dredging in their project to create a new 40- to 50-acre waterfront property in Battleship Cove. As described in paragraph 24, the material from the channels is generally unsuitable for landfill purposes and would result in an offensive nuisance and unstable foundation. It is, therefore, presently considered impractical and aesthetically undesirable to use the hydraulic landfill method for Battleship Cove or

any other area along the waterfront in Fall River, Somerset and Tiverton. In addition, in view of the largely developed areas contiguous to the channels, the recreational aspects of the surrounding areas, the conservation principles of other Federal and State agencies for preservation to marshlands, for fish and wildlife resources, and elimination or minimization of pollution, it is improbable that sufficient land areas along the waterfront, for disposal of the total volume of materials to be excavated, could be made available. It is considered that the most practicable manner of doing the work will be by bucket dredge with disposal in an ocean dumping ground 4.6 miles off Brenton Reef Light and project estimates are based on its use. Proposed use of this mile square area, which has recently been used for disposal of about 10,000,000 cubic yards of dredged materials from the Providence River project, has been tentatively disapproved by the U. S. Fish and Wildlife Service and Region I Water Quality Office of the Environmental Protection Agency because some of the Fall River bottom samples exceed the EPA criteria values defining polluted spoil. Inquiry pertaining to the use of the Brenton Reef Light Dump recently sent the Rhode Island Department of Natural Resources has not been officially answered. The area has been under surveillance by professors from the Marine Experiment Station of the University of Rhode Island. A more complete explanation of the testing, findings, and reports by the professors will be found in paragraph 34c.

26. Because the possibility exists that use of the Brenton Reef Light sea dump for dredged material from the Fall River project may not be approved, other alternates have been evaluated (see paragraphs 34a thru e for details).

27. Departures from the Project Document Plan. The present project plan is the same as that recommended in the authorizing document and authorized by Congress, with the exception of minor realignment of channel lines in the vicinity of the former locations of the Slades Ferry and Brightman Street Bridges.

28. Other Plans Investigated. No plans other than those discussed in the project-authorizing document, namely, four incremental channel deepenings to 37, 38, 40, or 45 feet, and providing a pipe line alternative, have been proposed or studied. Although costs for the five plans have escalated considerably since the date of the project document, so have the benefits. The reasons for selection of the 40-foot deep channel are probably even more valid today, than they were in the 1967 project document, since all electric power units have been converted to oil.

29. Project Formulation and Evaluation. Since only minor alterations have been made in channel alinements and no other plans have been proposed, (paragraph 28) it appears that the authorized 40-foot deep channels will provide the maximum benefits. This coupled with the

fact that Massachusetts has eliminated Slades Ferry Bridge and is planning the replacement of the Brightman Street Bridge with a draw-span bridge engineered to fit the channel, only the costs and benefits derived from deepening the channel to 40 feet need be considered.

30. Environmental Quality. The actual deepening of the present Fall River and Tiverton channels to 40 feet by bucket dredging will have little or no effect on the present environment over that which has occurred from previous dredgings over the past 100 years on the local Fall River, Tiverton, Mount Hope Bay area, other than to cause increases in turbidity and dissolution of some chemical fractions from the sediments.

31. Recent test results of materials within the areas to be dredged indicate that volatile solids, oil-grease, mercury and zinc percentages exceed the water-quality criteria. Even more recent tests on quahogs taken from locations in the Fall River and Tiverton channels showing the highest concentration of mercury and zinc show conclusively that most of the mercury and zinc must be in forms not absorbable by the animals because only traces of mercury and zinc were found in the flesh.

32. It is presumed that distribution of any of the pollutants in the local area can be minimized and perhaps eliminated by careful quality-control inspection during the dredging and by use of scows that are tight. Thus the effect of the dredging on the local area can be considered temporary and of short term importance. Shellfishing beds in Massachusetts waters are presently closed and those in Rhode Island waters are under limited operation. All shellfishing beds south of the project in Massachusetts and Rhode Island should be closed for the duration of the dredging operation because of the unavoidable turbidity and possible distribution of pollutants. Beds should not be reopened after completion of work until tests are made to determine if substances detrimental to man have been absorbed by the shellfish or other marine life.

33. Dredging (improvement) of private (local) berths and access channels to a depth commensurate with project depth will have an effect similar to that described in paragraph 30. It is probable that there are lesser amounts of pollutants in these areas and since quantities are much smaller, effect will be considerably reduced.

34. Disposal of Dredged Materials. Several methods of disposal of the dredged materials from the Fall River project have been studied.

a. Shore Disposal. (Including area contiguous to the Battleship Massachusetts) Even if sufficient areas could be found in the highly developed character of the surrounding terrain, more than 95 percent of the material is highly organic silt which is totally unsuitable for use as landfill.

b. Container Disposal. The possibility of depositing all the dredged material in a double wall steel sheet pile container in the Spar Island area (which has been formerly used for local materials disposal) was investigated. The container, approximately 3,000 feet in diameter, would be large enough to retain any overdredging and maintenance for the life of the project. This appeared to be a reasonable solution since any pollutants would be retained within the originating area, a 22-mile tow to the nearest sea disposal would be eliminated, and at some time in the future an island of about 200 acres would be available. Investigation and preliminary design indicates a cost of between 12 and 15 million dollars for construction. Although this cost would be reduced 4-5 million because of the shortened length of haul, current policies would require local interests to pay the 8 to 10 million balance which seems very unlikely. The "container" would be somewhat of an obstruction to small boat navigation and might be considered an eyesore by shore residents.

c. Near Shore Sea Disposal - Rhode Island Sound. Between December of 1967 and September of 1970 over 8 million cubic yards of material from the Providence River Improvement project, and between April 1970 and September 1970, 320 thousand cubic yards of material from the approach channel and berthing area of the New England Power Company's Brayton Point Plant (Fall River) was dumped in the sea disposal area 4.6 nautical miles off Brenton Reef Light.

Two studies completed by marine biologists from the University of Rhode Island cover the effects of dumping the Providence and Fall River materials into the Brenton Reef Light, Rhode Island Sound dump over the period indicated. The second report concludes, among other findings, that "The present site appears well chosen on the basis of minimal disturbances to regional fisheries and minimal erosion of spoil. There is an area within the site for a large volume of additional spoil." The report also indicated that although some of the earlier dredged sediments from the Providence dredging included polluted silts containing up to 12 percent organic matter, they had been buried by relatively unpolluted silty sands and varied clays dredged from areas further down Narragansett Bay. The report recommended that in dredging projects which include a variety of materials that precise dumping techniques be developed so that either unpolluted or coarse materials will bury polluted or very incohesive materials.

A third contract with the University of Rhode Island biologists for continued investigation of the effects of the materials deposited in the Brenton Reef Light dump with particular emphasis on the effect of heavy metals on marine animals and the fish-food chain relationship is underway. Results of these investigations will not be available until late in 1972.

There are compelling reasons why the Brenton Reef disposal area should be used for the dredged material from the Fall River improvement dredging. They are:

(1) The site was originally selected by the fishing interests and approved by all Federal and State officials for the Providence River channel improvement dredging.

(2) The site has been monitored, tested and studied before, during, and after dumping into it over 8,000,000 cubic yards of materials from the Providence River channel improvement project and more than 320,000 cubic yards of materials from the approach channels and berthing area of the New England Power Company's Brayton Point Plant on the Fall River Channel below the bridge.

(3) Since the site has already been committed as a dumping ground for spoil materials and has been thoroughly tested, studied and evaluated, it would provide a unique control site to assess the retention of the various elements of the E.P.A. criteria from the dredge site to the dump site. Materials excavated from the Fall River and Tiverton channels would be accurately placed at the dump site and continuously sampled and tested under the direction of the University of Rhode Island Marine Experimental Station biologists. Information generated would be analyzed by biologists of the New England Division.

(4) The site is within easy range of the present dredging and transportation equipment for disposal of materials from the Fall River improvement dredging project.

d. Off Shore Sea Disposal. If it appears that the near shore disposal cannot be used, the alternative would be an off shore site beyond the 180-foot contour of the continental shelf. The marine biologists from the University of Rhode Island in their second report on the effects of materials placed in the Brenton Reef Light dumping ground stated that in their opinion the most suitable area for the location of a permanent disposal area for Rhode Island and southern Massachusetts for polluted or large volumes of non-cohesive spoil seems to be an area about 215-feet deep some 51 nautical miles off Brenton Reef Light at the edge of an existing munitions dump. Bearing from Brenton Reef Light is 155 degrees true. Disposal in this area would require an average tow of about 70 nautical miles each way from the Fall River project. Trawl fishing rarely extends into depths below 180 feet. No off-shore lobster fishing comes within 45 nautical miles of this area. Ocean quahog fishing is developing in many areas, all inshore of this site. Indications are that there are little or no bottom currents and that very little if any erosion or transportation of dumped materials will take place. Disposal in this

area is technically possible, but is beyond the limit of the presently available equipment. If this area has to be used, it would require about a 4 million capital outlay for equipment and a total of 13 to 16 million more cost for disposal than the near-shore disposal in Rhode Island Sound.

e. Alternate Off Shore Sea Disposal. There is an area shown on the Coast and Geodetic Survey Chart No. 1108, a little over one mile in diameter, that is beyond the 180-foot contour which might be utilized for disposal of the Fall River materials. The distance from this area to Brenton Reef Light is about 30 nautical miles on a bearing of 184 degrees and 30 minutes, true. A study of the hydrography, geology, benthic ecology, fisheries potential, and bottom currents of this specific area should be made prior to any definite decision to dump Fall River spoil at this site.

This alternate offshore sea disposal area is just within the range capability of the presently available dredging and transportation equipment. If this area is used, it is estimated that it would increase project costs by about $5,000,000 and could increase contract time by 6 to 10 months. The cost increase would reduce the benefit to cost ratio for the whole project to about 1.7 to 1 and might reduce the ratio for some of the project increments below unity.

35. Local Assurance Actions. In accordance with items e. and f. of local assurances in the authorizing document and in general conformance with their agreement of 29 December 1966, the Commonwealth of Massachusetts has:

a. Demolished and removed Slades Ferry Bridge. Contract was begun 5 January 1970 and completed 8 April 1971.

b. Entered into a contract with Amann & Whitney Engineering Consultants of New York City for design, plans and specifications for a new Brightman Street Bridge which will become the connecting link for the Fall River Western Expressway, U. S. Route 6 and State Route 138. Several conferences with Amann & Whitney and Massachusetts D.P.W. indicate that the layout and design will now conform to the criteria established for the improved Fall River Channels. Present advice indicates that actual construction may not begin until 1974 and that obstructive bridge may not be removed and channel cleared for navigation until late 1977.

36. Cost Estimates (Authorizing Document). The estimates of project costs reported in the authorizing document were based on prices current in November 1966.

a. Federal First Costs. Materials and Quantities to be dredged used in the authorizing document were based upon probings, borings and hydrographic surveys made in 1961, 1962 and 1963 tempered by previous dredging experience in the channels. It was estimated that to deepen the channels to 40 feet would require removal of 2,600,000 cubic yards of mud, clay, sand and gravel from the Mt. Hope Bay-Taunton River channel and 1,400,000 cubic yards of the same type of materials from the Tiverton channel. Dredging would be accomplished by bucket dredge with disposal in a sea dump. In addition to dredging, a portion ($3,178,000 - Principles of Truman-Hobbs Act) of the alteration of the obstructive bridge at Brightman Street, discussed in the previous paragraph was considered as Federal cost. Total Federal first cost was estimated as $8,762,000 for dredging and bridge alterations.

b. Non-Federal First Costs. No land acquisition is involved in the project. The Slades Ferry Bridge was to be replaced by the high level Braga Bridge (completed 1966). Costs of removal of the Slades Ferry Bridge were considered self-liquidating because the high maintenance costs of the obsolete structure were eliminated. Other costs such as berth and approach channel improvements commensurate with the Federal channel depths being the responsibility of the individual terminal owners were also considered as self-liquidating. The only remaining non-Federal cost was therefor the $497,000 to be paid by the Commonwealth of Massachusetts as its share for the alterations of the Brightman Street Bridge under the principles of the Truman-Hobbs Act.

37. Current Cost Estimates (Design Memo). The current estimates of project first costs are based on construction prices prevailing on 1 July 1972.

a. Federal First Costs. The current estimate of costs are based on quantities determined from the soundings and detailed boring and probing surveys of 1970 and 1971, supplemented by previous borings and probings and by reference to previous dredging experiences in the various project areas. Alinement of about 4,500 feet of the Fall River channel spanning the former location of the Slades Ferry and Brightman Street Bridges was moved approximately 30 feet southwest to avoid an area of hard mixtures of materials. Dredging quantities are in terms of in-place measurement with a 2-foot overdepth allowance. Subaqueous exploration indicates materials to be encountered are predominantly organic silt although some clay, sand and gravel was encountered in scattered areas. Past experience in dredging points to an area of boulders along the south branch of the Tiverton channel near the east edge and in front of the oil terminals, although recent probings did not locate any. For the current estimate it was assumed that all material would be removed by bucket dredge, placed

in a scow and towed to a dumping ground in Rhode Island Sound 4.6 nautical miles off Brenton Reef Light (the Providence Dump). Side slopes were assumed to be 1 vertical on 3 horizontal in all materials.

Recent advice from the Commonwealth of Massachusetts indicates that construction of the New Brightman Street Bridge and removal of the present obstructive bridge may not be completed until late 1977 or early 1978. Consequently, the Office of the Chief of Engineers on 17 September 1971 ruled that the project will be undertaken in two contracts. The first contract will be to dredge the Mt. Hope Bay-Taunton River Channel (2,420,000 cubic yards) below the bridge and will include the Tiverton Channel (1,700,000 cubic yards). The total quantity in the first contract does not include 180,000 cubic yards maintenance dredging of the 35-foot channels. The second contract will complete the dredging of the Mt. Hope Bay-Taunton River Channel above the bridge and the turning basin at the head of navigation (430,000 cubic yards). This quantity does not include 70,000 cubic yards of maintenance of the 35-foot channel. Since the first contract will be accomplished under a continuing contract over an estimated 24-month period, an allowance for channel shoaling has been included in the quantity estimates. In the current estimate, a cost of $5,180,000 for alterations of the Brightman Street Bridge (Principles of Truman-Hobbs Act) has been included. In addition to the actual construction costs, the amount of $115,000 for Federal supervision and administration of bridge work increases the total Federal contribution for the bridge to $5,295,000.

b. Non-Federal First Costs. Although total non-Federal costs are presently estimated as $2,500,000 only $782,000 of this amount (Massachusetts portion of the "Bridge Alterations") is considered as unrecoverable. The $400,000 for demolition and removal of the Slades Ferry Bridge and the $1,318,000 estimated for the terminal owners to provide adequate depths in approach channels and berthing areas commensurate with depths provided in the Federal project, are considered as "self-liquidating."

38. Detail Current Estimate of Costs (July 1972)

40-Foot Channel Construction Costs

Federal First Cost

Mt. Hope Bay-Fall River Harbor Channel
Above Bridge

Dredging 430,000* c.y. @ $2.70	$1,163,000	
Contingencies 12%	139,000	
	$1,302,000	
Engineering & Design	39,000	
Supervision & Administration	49,000	
Total Above Bridge (Mt. Hope Bay-Taunton River Channel)		$1,390,000

*Includes 200,000 cubic yards of 2-foot allowable overdepth dredging but does not include 70,000 cubic yards maintenance dredging for the 35-foot channel.

Below Bridge

Dredging 2,420,000* c.y. @ $2.70	$6,537,000	
Contingencies 12%	801,000	
	$7,338,000	
Engineering & Design	218,000	
Supervision & Administration	274,000	
Total Below Bridge (Mt. Hope Bay-Fall River Harbor Channel)		$7,830,000

*Includes 1,100,000 cubic yards of 2-foot allowable overdepth dredging but does not include 80,000 cubic yards maintenance dredging for the 35-foot channel.

Tiverton Channel

Dredging 1,700,000* c.y. @ $2.70	$4,585,000	
Contingencies 12%	555,000	
	$5,140,000	
Engineering & Design	153,000	
Supervision & Administration	192,000	
		$5,485,000

*Includes 700,000 cubic yards of 2-foot allowable overdepth dredging but does not include 100,000 cubic yards maintenance dredging for the 35-foot channel.

Bridge Alteration (Brightman St.)

Bridge Alt. (Fed. portion Truman-Hobbs)	$5,180,000*	
Supervision & Administration (Fed)	115,000	
Total Bridge Alt. (Fed)		$5,295,000

*Includes Non-Federal Engineering & Design, Supervision & Administration

TOTAL FEDERAL FIRST COST	$20,000,000

Non-Federal First Cost

Bridge Alteration (Non-Federal portion Truman-Hobbs)	$ 782,000*	
*Includes Non-Federal Engineering & Design, Supervision & Administration		
Lands and Damages	$ 0	
Bridge Removal (Slades Ferry)	400,000*	
Berth Improvements	1,318,000*	
Total Non-Federal First Costs		$2,500,000
TOTAL FEDERAL AND NON-FEDERAL FIRST COSTS		$22,500,000

*Considered as self-liquidating costs

39. Reasons for Variations from Authorizing Document.

a. Increase in cost of removal of materials is based on increased quantities and reflects an increase in dredging costs based on current unit prices. Included in the increased dredging cost is an increase in towage cost and an additional charge for dump inspector costs due to the necessity of more accurate position control of load dumping.

b. A slight decrease in overall dredging cost will result from the minor realignment of channel lines in the vicinity of the former Slades Ferry and Brightman Street Bridges to avoid an area of "hard digging".

c. A considerable portion of the increase in cost of Engineering and Design was occasioned by the extensive sampling program required by the Environmental Protection procedures recently set up.

d. The increase in cost of Supervision and Administration reflects costs due to increase in contract amount and a re-estimate of Government costs based on present schedule of construction.

e. Division of the project into two dredging contracts as outlined in paragraph 37 (detail contract one and contract two in paragraph 40) will undoubtedly result in an increased cost in contract two. Contract two cannot be initiated until the Commonwealth of Massachusetts completes the New Brightman Street Bridge and removes the old obstructive bridge. Any estimate for a dredging contract starting at least two years after completion of contract one would be pure conjecture. For this reason all elements of the detailed project estimate for the dredging contracts are based on current (July 1972) prices.

40. Detail Estimate (July 1972). (Contract 1 and 2 Dredging)

Federal First Cost (Contract 1)

Mt. Hope Bay-Fall River Harbor Channel
Below Bridge

Dredging 2,420,000 c.y. @ $2.70	$6,537,000	
Contingencies 12%	801,000	
Total Dredging	$7,338,000	
Engineering & Design	218,000	
Supervision & Administration	274,000	
Total Below Bridge		$7,830,000

Tiverton Channel

Dredging 1,700,000 c.y. @ $2.70	$4,585,000	
Contingencies 12%	555,000	
Total Dredging	$5,140,000	
Engineering & Design	153,000	
Supervision & Administration	192,000	
Total Tiverton Channel		$5,485,000
Total Contract 1 (C of E Funds Only)		$13,315,000

Detail Estimate (July 1972) (Contract 1 and 2 Dredging) Cont'd

Federal First Cost (Contract 2)

Mt. Hope Bay-Fall River Harbor Channel
Above Bridge

Dredging 430,000 c.y. @ $2.70	$1,163,000	
Contingencies 12%	139,000	
	$1,302,000	
Engineering & Design	39,000	
Supervision & Administration	49,000	
Total Contract 2 (C of E Funds Only)		$1,390,000
Total Contract 1 and 2 Dredging		$14,705,000

41. Schedule for Design and Construction. The entire project for the improvement of Fall River Harbor, Massachusetts and Rhode Island that will be paid for with Federal funds will be accomplished under at least three contracts. The dredging portion will be divided into two contracts. The first contract will be the dredging below the Brightman Street Bridge in the Mt. Hope Bay-Fall River Harbor Channel and will include dredging of the Tiverton, Rhode Island Channel. The second dredging contract will be that portion of the Fall River Harbor Channel in the Taunton River above the Brightman Street Bridge and will include the turning basin at the head of navigation.

42. Federal funds in accordance with the principles of the Truman-Hobbs Act amounting to about 86.8 percent of the costs, will be paid to the Commonwealth of Massachusetts for the construction of a new Brightman Street Bridge. The State has an Architect-Engineer firm under contract for the design, plans and specifications for this new bridge complex. The Corps has coordinated the layout with the navigational needs. The best advice from the State and the Architect-Engineer indicates that construction of the new bridge and removal of the old obstructive bridge cannot be completed until late 1977 or early 1978. Actual start of construction is tentatively programmed for late 1974.

43. Since the start of the second dredging contract is dependent upon the completion of the new bridge and the removal of the old, only an approximate date can be assigned for the dredging. Present (1972) soundings indicate that about 430,000 cubic yards (not including 70,000 cubic yards maintenance dredging of the 35-foot channel) of material will have to be removed. This amount of material could be dredged and disposed of

in approximately five months; however, since there will be a time lapse of over six years, new soundings will be required to determine quantities, and costs will have to be re-evaluated at that time.

44. The present project schedule, dependent upon approval of this Design Memo, upon approval of the recommended sea dump site, upon fulfillment of the requirements of local cooperation, and upon funding is as follows:

Contract 1 Dredging (4,120,000 cubic yards, not including 180,000 cubic yards maintenance dredging of the 35-foot channel)

Issue Advance Notice	Feb. 1973
Issue Plans and Specifications	Feb. 1973
Open Bids	March 1973
Award Contract	April 1973
Complete Construction	May 1975

New Brightman Street Bridge
(Commonwealth of Massachusetts)

Start Construction	Aug. 1974
Complete Construction	March 1977
Start Remove Old Bridge	April 1977
Complete Removal	Nov. 1977

Contract 2 Dredging (430,000 cubic yards, not including 70,000 cubic yards maintenance dredging of the 35-foot channel)

Start Dredging	Dec. 1977
Complete Dredging	June 1978

45. The time required for completion of Contract 1 dredging is 24 months. Present estimate, based on information from the Commonwealth of Massachusetts for the entire project, is 64 months, subject to availability of funds. The current fund requirements as of June 1972 are as follows:

Federal First Costs, Improvement of Fall River Harbor Channels, Massachusetts and Rhode Island.

Allotted to 30 June 1972	$ 850,000	
Fiscal Year 1973	0	
Fiscal Year 1974	6,500,000	
Fiscal Year 1975	5,965,000	
Subtotal (Contract 1, Dredging)		$13,315,000
Bridge Alterations	$5,295,000	
Dredging above Bridges (Contract 2)	1,390,000	
Subtotal (Balance of Project)		6,685,000
TOTAL COSTS (C of E Funds Only)		$20,000,000

46. Operation and Maintenance. Maintenance of the project is a Federal function and will consist of periodic dredging to restore project depths within the limits of the Federal project. The estimated additional annual maintenance quantities are based primarily on shoaling experienced in the existing channels adjusted for the greater project depths and for widening bend leading into Tiverton upper channel to 600 feet. The additional annual maintenance cost is estimated as $48,000. This is based on an additional total shoaling of 18,000 cubic yards per year, 14,500 cubic yards in Mt. Hope Bay-Fall River Harbor Channel (below bridge including Tiverton Channel (Contract 1) and 3,500 cubic yards per year in the Fall River Channel and Turning Basin (above bridge) (Contract 2)). Estimate for Contract 1 is $39,000 and for Contract 2 $9,000.

47. Benefits. The benefit analysis is based on a 50-year project life at 3.25 (1) percent interest rate. The benefits are considered general in nature and are expected to accrue from the same sources as stated in the Review Report. Current benefits are based on a re-analysis of those in the authorizing document to reflect current price levels, refined commerce projections based on the latest available statistics, on a reduction in projected population growth, and a reduction in the projected fuel needs of the Montaup Electric Co. due to cutting of the planned future power plant from about 1.5 million kw to 600,000 kw. It is known that at least two oil companies are negotiating for a location in the Fall River-Tiverton area to construct a multi-million dollar refinery and chemical plant, another company has a 35-acre site in Fall River upon which they want to construct a multi-million dollar "Energy Center", and an Architect-Engineer firm is investigating possibilities of setting up an "overseas" auto terminal in the vicinity of Borden's Wharf in Tiverton. No benefits have been assigned for the possible future construction of these projects. If any one of the projects were built within the 50-year life of the Fall River Harbor improvement project, it would add substantially to the benefits "below the bridge".

48. Improvement of the waterways will result in important benefits, not only for the immediate locality but also for an irregularly shaped area extending outward from Fall River as far as Worcester and Boston, Massachusetts, containing about 1,189,000 people. The benefits result from more economical transportation of the various items which will comprise the future waterborne commerce. Transportation savings will be realized in four general areas; namely, elimination of restrictive bridges, the use of larger and deeper draft vessels, and the reduction in required annual towboat costs.

49. The benefits have been divided into four general categories. These are general growth, existing power plants, (all of the electric units listed in the authorizing document as coal fired have now been converted

(1) Retained evaluation interest rate in accordance with the regulation of the Water Resources Council issued 24 December 1968 for already authorized projects.

to oil) new power plants and new units in existing plants, and towboat hire. Benefits in the above categories were computed for the Fall River Harbor and Tiverton Channels. In addition, the benefits for the Fall River Harbor channel were separated into those benefits attributable to the channel below the bridge, above the bridge, and to removal of the bridge. The general growth category is the increase in petroleum and petroleum products expected to occur over the project life due to population growth, new and more varied uses of petroleum products and increases in use of fuel oil for industrial purposes and domestic heating. These petroleum deliveries are expected to increase from 2,400,000 tons to 5,100,000 tons annually during the life of the project. It is assumed that this oil will be carried by U. S. Tankers (domestic) and one half of the benefits will be allocated to the port of origin. During the project life period of 50 years, larger tankers can be used resulting in significant savings.

All the oil deliveries to the existing electrical power units and to the new power plants are expected to be carried in foreign vessels, full benefits will accrue from the increase from 1,800,000 tons to 3,000,000 tons annually during the life of the project.

The existing Power Plant benefit category is the shipping savings which would accrue to oil tanker deliveries to existing power plants on the channels.

The new Power Plants and Units category is the shipping savings which would develop from use of the larger oil tankers for delivery of oil for the additional electric capacity expected to be installed in the Montaup Electric Company plant above the bridges and to a 600,000 kw plant to be erected on the Montaup Electric Company's site below the bridges. The New England Power Company expects to complete a 450,000 kw addition to its Brayton Point plant in 1973. The increased oil deliveries required for the new power units and the new plant to be constructed amounts to 760,000 tons of oil annually based on the same oil to kw ratio as indicated in the Review Report. The towboat hire benefit is derived from the reduction in the number of vessel trips due to use of larger capacity tankers. The benefits obtained from the elimination of tidal delays to present and future commerce has been included in benefits computed for the other items.

50. The Office of the Chief of Engineers by teletype dated 17 September 1971, issued instructions that dredging of the channel above the Brightman Street Bridge be deferred until the Commonwealth of Massachusetts completes the new bridge. The work on the channel above the bridge will be coordinated with the removal of the existing bridge. Based on information from the State, it is estimated that the channel above the

bridge will be dredged four years after the dredging of the channel below the bridge is completed. Beginning of benefits for bridge and channel above the bridge are therefor computed on the basis of project year (completion of channel below bridge) plus four years.

51. Complete detailed analysis and derivation of benefits are attached as Appendix A. The benefits anticipated from the improvement of the Fall River and Tiverton channels are summarized as follows:

Location	Benefit Annually	
Fall River Channel Below Bridge	$1,251,000	
Tiverton Channel	288,000	
(Contract 1) Total Below Bridge and Tiverton		$1,539,000
	Average Annual Equivalent	
Bridge Alteration	$1,114,000	
Fall River Channel Above Bridge (Contract 2)	180,000	
Total (Balance of Project)		$1,294,000
Total Benefits Fall River Project		$2,833,000

52. Annual Charges. Annual charges computed in the authorizing document were based on an assumed 50-year life at an interest rate of 3.125 percent. Additional annual maintenance costs were based on shoaling experienced in the existing channels with adjustments to reflect dimensions of the proposed channels. Current annual charges are computed at an interest rate of 3.25 percent over a 50-year project life. Additional annual maintenance costs are based on experienced shoaling in the existing channels and turning basin and adjusted to reflect the increased dimensions of the recommended channels and basin including shoaling apparent by comparison of soundings made in 1963 and in 1971.

53. Cost Allocation and Annual Charges - Summarized.

Fall River Harbor and Tiverton Channels
40-Foot Channels & Turning Basin

Federal Investment
Federal First Cost (C of E)

Mt. Hope Bay-Fall River Harbor Channel (Below Bridge)	$7,830,000	
Tiverton Channel	5,485,000	
Total Contract 1		$13,315,000
Bridge Alteration (Fed. Portion)	$5,295,000	
Fall River Channel & Turning Basin (Contract 2)	1,390,000	
Total (Balance of Project)		6,685,000
TOTAL FEDERAL INVESTMENT		$20,000,000

Non-Federal Investment
Non-Federal First Cost

Bridge Alteration (Non-Federal Portion)	$ 782,000	
TOTAL NON-FEDERAL INVESTMENT		$ 782,000
TOTAL FEDERAL & NON-FEDERAL INVESTMENT		$20,782,000

Federal Annual Charges

Project Life	50 years	
Contract 1, Interest 3.25%	$432,000	
Amortization (0.00823)	109,000	
Additional Annual Maintenance	39,000	
Total Contract 1	$580,000	
Balance of Project, Interest 3.25%	$219,000	
Amortization (0.00823)	55,000	
Additional Annual Maintenance	9,000	
Total Balance of Project	$283,000	
TOTAL FEDERAL ANNUAL CHARGES		$863,000

Non-Federal Investment		
Bridge Alteration	$782,000	
TOTAL NON-FEDERAL INVESTMENT	$782,000	
Non-Federal Annual Charges		
Interest 3.25%	$ 27,000	
Amortization (0.00823)	7,000	
TOTAL NON-FEDERAL ANNUAL CHARGES		$ 34,000
TOTAL FEDERAL AND NON-FEDERAL CHARGES		$897,000

54. An overall comparison of the project annual benefits of $2,833,000 to the estimated annual charges of $897,000 yields a benefit to cost ratio of 3.2 to 1.

Item	First Cost	Benefits	Annual Charges	Benefit/ Cost Ratio
Contract 1	$13,315,000	$1,539,000	$580,000	2.7/1
Balance of Project(1)	7,467,000	1,294,000	317,000	4.7/1
Totals	$20,782,000	$2,833,000	$897,000	3.2/1

(1) Includes $782,000 Non-Federal first cost and $34,000 annual charges.

55. Recommendations. The overall recommendations for Improvement Dredging in Fall River Harbor, Massachusetts and Rhode Island consist of:

a. Deepening the existing 400-foot wide by 35-foot deep Mt. Hope Bay-Fall River Harbor-Taunton River Channel to 40 feet within the existing channel limits, from deep water in Mt. Hope Bay to and including the existing turning basin in the Taunton River, upriver of the bridge;

b. Deepening the existing 400-foot wide by 35-foot deep Tiverton Channel to 40 feet to the vicinity of the Tiverton shore, thence upstream to the vicinity of the Gulf Oil Terminal, and widening the bend leading to this upper channel to 600 feet;

c. Providing a channel 400 feet wide and 40 feet deep along the waterfront in Tiverton Lower Pool to the vicinity of the Northeast Petroleum Corporation;

d. Altering the Brightman Street Bridge to provide for a clear channel width of 300 feet through the drawspan. (Principles of Truman-Hobbs Act) This overall project plan is the same as that recommended in

the authorizing document and authorized by Congress. All the features listed above are substantially in accordance with the plan of the Division Engineer as shown on the maps accompanying his report of February 1967.

56. Specific Recommendations. The Commonwealth of Massachusetts has removed one obstructive bridge, Slades Ferry Bridge, at its own expense. The second obstructive bridge, Brightman Street Bridge, has been the subject of extensive study, taking into consideration traffic pattern changes, increased vehicular units, speeds, etc., and the necessity for providing an interconnection for the Fall River Western Expressway, U. S. Route 6, and State Route 138. As a result of this study, the Commonwealth of Massachusetts has decided to replace the bridge built in 1914 with a modern structure capable of handling the present and future traffic. The State has employed an Architect-Engineer to design and prepare plans and specifications, but has indicated that completion of the new bridge and removal of the old probably cannot be accomplished before late 1977 or early 1978. As a result, the Office of the Chief of Engineers by teletype dated 17 September 1971 advised that the dredging of the Fall River Harbor project be done in two contracts. The Division Engineer concurs with the instructions and makes the following specific recommendations:

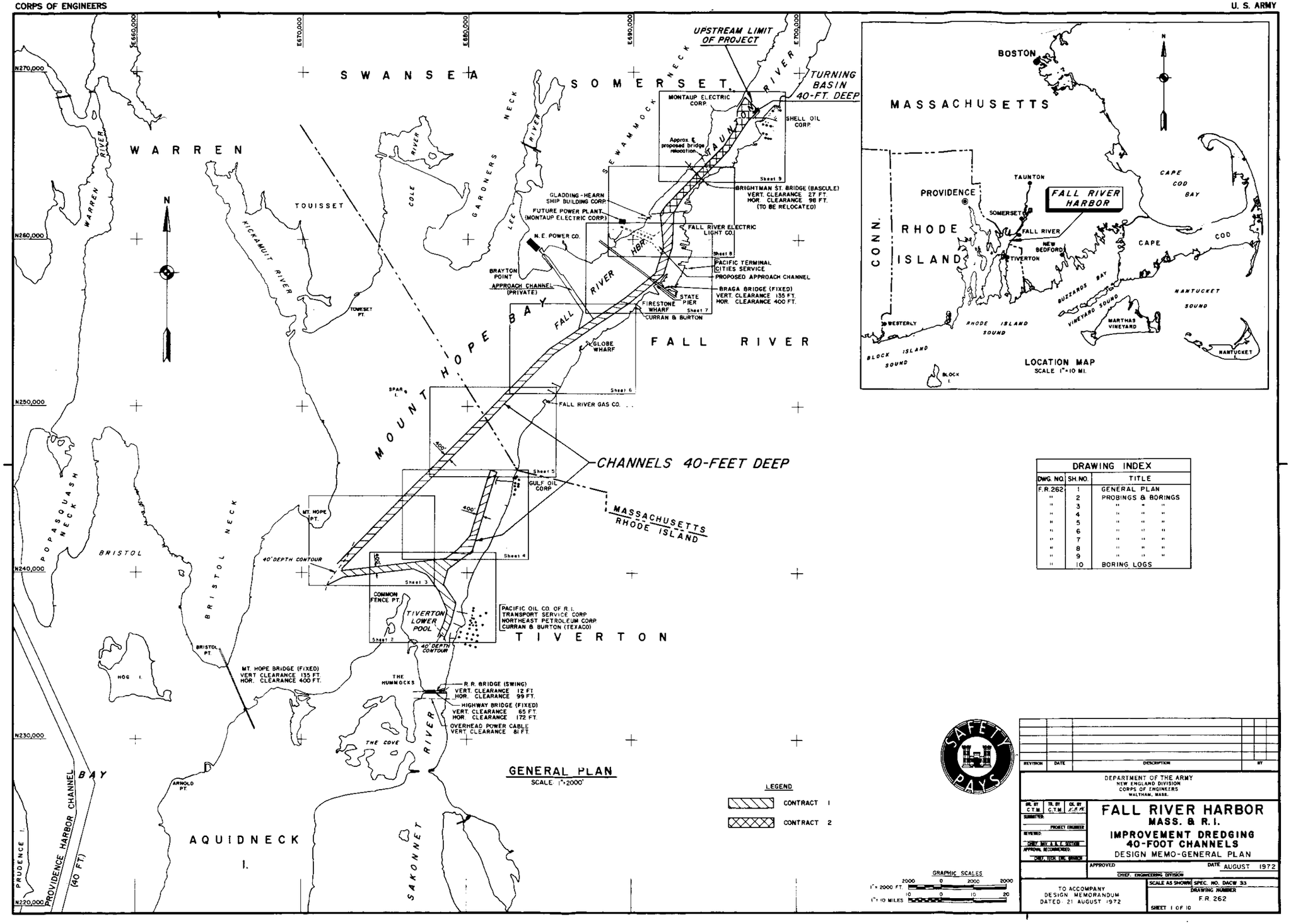
a. That the first dredging contract, which will include dredging to 40 feet deep of the 400-foot wide channel from deep water in Mt. Hope Bay upriver in the Fall River Harbor to a point about 3,000 feet below the present Brightman Street Bridge and both items b. and c. of paragraph 55 above, Tiverton, Channel, be accomplished in accordance with the schedule set forth in paragraph 44;

b. Altering the Brightman Street Bridge to provide for a clear channel width of 300 feet through the drawspan. (Principles of the Truman-Hobbs Act) (Construction by the Commonwealth of Massachusetts)

c. That the second dredging contract, which will include the balance of the dredging to 40 feet deep and 400 feet wide of the channel in Fall River Harbor and the Taunton River from the upstream limit of the first dredging contract upriver thru the bridge location to and including the turning basin at the head of navigation, be coordinated with the Commonwealth of Massachusetts, and be initiated immediately upon the completion of the New Brightman Street Bridge and the removal of the old obstructive bridge.

CORPS OF ENGINEERS

U. S. ARMY



DRAWING INDEX		
DWG. NO.	SH. NO.	TITLE
F.R.262	1	GENERAL PLAN
"	2	PROBINGS & BORINGS
"	3	" " "
"	4	" " "
"	5	" " "
"	6	" " "
"	7	" " "
"	8	" " "
"	9	" " "
"	10	BORING LOGS

GRAPHIC SCALES

2000 0 2000 2000

1"= 2000 FT.

10 0 10 20

1"= 10 MILES

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY C.T.M. | TR. BY C.T.M. | CK. BY F.P.K.

SUBMITTED: PROJECT ENGINEER

REVIEWED: CHIEF, NAV. & H.S. SECTION

APPROVAL RECOMMENDED: CHIEF, TECH. ENG. BRANCH

APPROVED: CHIEF, ENGINEERING DIVISION

DATE: AUGUST 1972

FALL RIVER HARBOR
MASS. & R.I.
IMPROVEMENT DREDGING 40-FOOT CHANNELS
DESIGN MEMO-GENERAL PLAN

TO ACCOMPANY DESIGN MEMORANDUM DATED: 21 AUGUST 1972

SCALE AS SHOWN | SPEC. NO. DACW 33

DRAWING NUMBER F.R. 262

SHEET 1 OF 10

CORPS OF ENGINEERS

U. S. ARMY

LIST OF PROBINGS

NUMBER	DEPTH OF WATER (ELEVATION BELOW M.L.W.)	DEPTH OF PROBE	PENETRATION DEPTH BY HAND	METHOD OF PROBING: DRIVE LENGTH OVER BLOW COUNT
1	39.6	45.0	5.4	
2	37.1	45.0	7.9	
3	37.9	45.0	7.1	
4	35.9	45.0	9.1	
5	36.4	45.0	8.6	
6	34.1	45.0	10.9	
7	37.6	47.6	10.0	
8	38.8	45.0	6.2	
9	32.9	45.0	12.1	
10	37.8	45.3	7.5	
11	27.2	45.2	18.0	
12	26.4	45.0	18.6	42.5
19	25.3	45.0	19.7	
20	38.4	45.0	6.6	42.6
21	32.2	45.0	12.8	
22	36.2	45.0	8.8	36.8
60	37.0	50.0	13.0	39.2
61	34.8	50.0	15.2	36.4
62	34.7	50.0	15.3	38.1
63	36.5	50.0	13.5	39.0
64	34.0	50.0	16.0	37.4
65	34.3	50.0	15.7	36.7
66	35.1	50.0	14.9	38.6
67	36.2	50.0	13.8	39.0
68	34.5	50.0	15.5	37.5
69	32.5	50.0	17.5	38.6
70	32.5	50.0	17.5	36.7
71	33.5	50.0	16.5	39.0
72	32.7	50.0	17.3	37.5
73	31.5	50.0	18.5	39.0
74	31.5	50.0	18.5	38.5
75	33.0	50.0	17.0	38.5
76	33.2	50.0	16.8	37.4
77	31.3	50.0	18.7	37.2
78	32.2	50.0	17.8	36.9
79	33.0	50.0	17.0	37.5
80	32.4	50.0	17.6	37.5
81	36.5	50.0	13.5	50.0
82	35.3	50.0	13.7	40.2
85	36.0	50.0	14.0	50.0
86	36.8	50.0	13.2	42.1
87	38.1	50.0	11.9	43.0

APRIL - JULY 1962

MARCH 1970

N241,000

N240,000

N239,000

N238,000

N237,000

N236,000

E675,000

E676,000

E677,000

E678,000

E679,000

E680,000

E681,000

MATCH SHEET 3

MATCH LINE SHEET 4

400'

600'

EXISTING 35 FT. CHANNEL

EXISTING 35 FT. CHANNEL

PENN. CENTRAL R.R.

PACIFIC OIL CO. OF R.I.

PACIFIC (1944)

BAY (1948) TRANSPORT SERVICE CORP.

NORTHEAST PETROLEUM CORP.

COMMON FENCE PT. (1945)

COMMON FENCE PT.

MOUNT HOPE BAY

TIVERTON

TIVERTON

LOWER POOL

Flood

Ebb

40' DEPTH CONTOUR

P-1 P-2 P-3 P-4 P-5 P-6 P-7 P-8 P-9 P-10 P-11 P-12 P-13 P-19 P-20 P-21 P-22

FD-19 FD-20 FD-21 FD-22 FD-23 FD-24

K78 K79 K80 K81 K82 K83 K84 K85 K86 K87 K88 K89 K90 K91 K92 K93 K94 K95 K96 K97

KE-13 KE-15 KE-16

85 86 87 80 81 82

N

GRAPHIC SCALES

1" = 200'

0 200 400

SAFETY PAYS

LIST OF KULLENBERG SAMPLES

	NUMBER	BOTTOM EL.	DEPTH RANGE IN FEET	MATERIALS
	K78	40.2	0.0-1.8	Organic silty SAND
				Trace of pea gravel
	K79	37.6	0.0-3.1	Organic SILT
	K80	36.5	0.0-3.9	" "
	K81	38.8 recvd	0.0-2.3	" "
			2.3-4.4	Organic silty SAND
	K82	36.0	0.0-1.8	Organic SILT
			1.8-4.3	Gravelly SAND
*	K83	38.3	0.0-5.0	Organic SILT
	K84	45.7	0.0-5.0	" "
*	K85	38.9	0.0-5.0	" "
	K86	32.4	0.0-4.2	" "
			4.2-5.0	Stratified SILT & CLAY
	K87	38.1	0.0-3.2	SAND
			3.2-4.9	Organic SILT
	K88	37.3	0.0-5.0	" "
*	K89	36.1	0.0-5.0	" "
	K90	37.1	0.0-2.7	" "
			2.7-3.5	Sandy organic SILT
			3.5-4.1	SAND
	K91	38.1	0.0-3.2	Sandy organic SILT
			3.2-5.0	Organic silty SAND
	K92	35.9	0.0-5.0	Organic SILT
*	K93	35.9	0.0-5.0	" "
	K94	35.5	0.0-5.0	" "
	K95	35.1	0.0-5.0	" "
	K96	34.8	0.0-5.0	" "
	K97	36.8	0.0-4.2	Sandy organic SILT
	KE-13	37.7	0.0-5.0	Organic clayey SILT w/shells
	KE-15	37.7	0.0-5.0	" " " "
	KE-16	36.9	0.0-3.2	" " " "

SYMBOLS

- ● P-(No.)------1962-63 probings were made by driving an "A" drill rod (9/16" I.D.- 1-5/8" O.D.) with a 142 lb. hammer having a free fall of 18".
- ● (No.)------1970 probings were made by driving an "AW" drill rod (5/8" I.D.-1-3/4" O.D.) with a 143 lb. hammer having a free fall of 18".
  Probings are in feet and tenths and are referred to the plane of Mean Low Water.
- ◎ FD-(No.)------1953 & 1970 Test borings. For graphic logs and other data, see Sheet 18.
- □ K(No.)------1970 Kullenberg piston core bottom samples
- ■ KE-(No.)------1970-71 Kullenberg piston core bottom samples (Environmental)

NOTES:

Kullenberg samples were obtained inside a 1-7/8" I.D., 2" O.D. transparent plastic liner tube contained inside a 5-1/2 ft. standard black iron pipe fitted with a beveled and sharpened drive shoe. Penetration was by free fall of 5 ft., except where noted otherwise. The assembly was ballasted with 360 lbs. of lead weight, except where noted otherwise. Free fall distance was controlled by a release mechanism which was triggered by a suspended pilot weight trip which struck the bottom at a fixed distance below the cutter head. The sample was induced in the tube by means of a gasketed piston, suspended at bottom level by a wire rope and the core barrel fell around the fixed piston. A spring leaf type core catcher between the core tube and the barrel retained the sample.

Bottom elevations were by leadline and were reduced by tide curve. Locations were by sextant, plotted on computer drawn sextant charts automatically computed from survey coordinated sights. Samples were taken from Corps of Eng. tugboat Monamet. Description of materials are those of the Inspector, R. Semonian, unless accompanied by asterisk * denoting laboratory analysis and classification.

Field books: R.B.H. 1528, 1976, 1977, 1978, 1996, 2077, 2078, 3005 & 3006

B.M. No. 2 (1931) Elev. 28.26 ft. above M.L.W., Tiverton, R.I.

B.M. No. 2 (1955) Elev. 11.48 ft. above M.L.W., Fall River, Mass.

40-ft. depth contour shown thus: ———

Topography from enlargement of U.S.C.&G.S. Chart 350 and previous data.

Coordinates are on the Lambert Grid System for the Commonwealth of Mass.

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY	TR. BY	CK. BY
ALD	ALD	J.F.H.

SUBMITTED: PROJECT ENGINEER

REVIEWED: CHIEF, NAV. & E & T SECTION

APPROVAL RECOMMENDED: CHIEF, TECH. ENG. BRANCH

APPROVED: CHIEF, ENGINEERING DIVISION

DATE AUGUST 1972

FALL RIVER HARBOR
MASS. & R.I.
IMPROVEMENT DREDGING 40-FOOT CHANNELS
DESIGN MEMO- PROBINGS AND BORINGS

TO ACCOMPANY DESIGN MEMORANDUM DATED: 21 AUGUST 1972

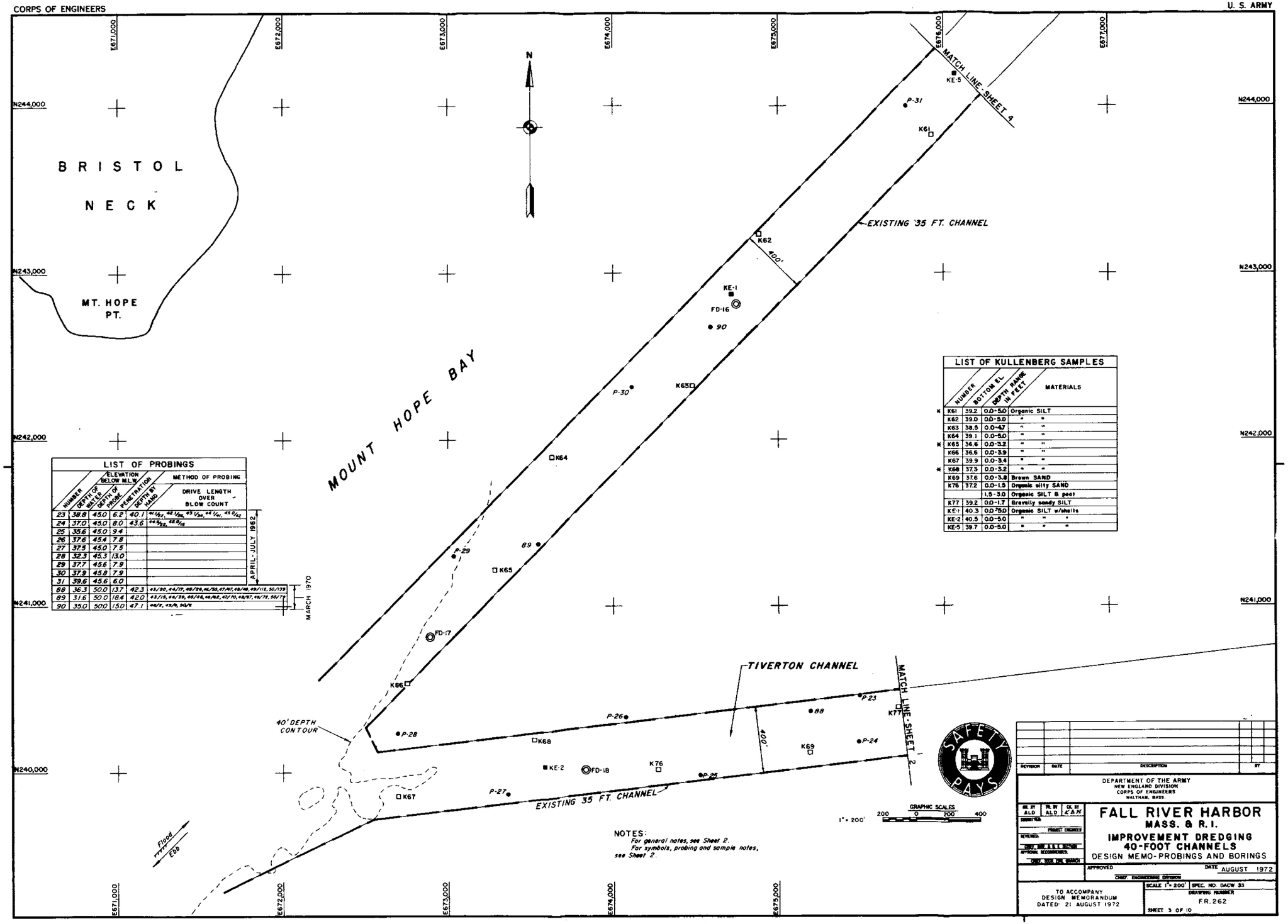
SCALE 1"=200' SPEC. NO. DACW 33

DRAWING NUMBER F.R. 262

SHEET 2 OF 10

CORPS OF ENGINEERS

U. S. ARMY



LIST OF PROBINGS

NUMBER	DEPTH OF WATER	ELEVATION BELOW MLLW DEPTH OF PROBE	PENETRATION DEPTH BY HAND	METHOD OF PROBING DRIVE LENGTH OVER BLOW COUNT	
23	38.8	45.0	6.2	40.1	41/12", 42 1/2", 43 1/2", 44 1/2", 45 0/12
24	37.0	45.0	8.0	43.6	44 5/12", 45 0/12
25	35.6	45.0	9.4		
26	37.6	45.4	7.8		
27	37.5	45.0	7.5		
28	32.3	45.3	13.0		
29	37.7	45.6	7.9		
30	37.9	45.8	7.9		
31	39.6	45.6	6.0		
88	36.3	50.0	13.7	42.3	43/20, 44/17, 45/28, 46/30, 47/17, 48/18, 49/11", 50/7.5"
89	31.6	50.0	18.4	42.0	43/15, 44/39, 45/48, 46/52, 47/10, 48/17, 49/7.5", 50/7.5"
90	35.0	50.0	15.0	47.1	46/7, 47/8, 30/8

APRIL - JULY 1982

MARCH 1970

LIST OF KULLENBERG SAMPLES

	NUMBER	BOTTOM EL.	DEPTH RANGE IN FEET	MATERIALS
*	K61	39.2	0.0-5.0	Organic SILT
	K62	39.0	0.0-5.0	" "
	K63	38.6	0.0-4.7	" "
	K64	39.1	0.0-5.0	" "
*	K65	36.6	0.0-3.2	" "
	K66	36.6	0.0-3.9	" "
	K67	39.9	0.0-3.4	" "
*	K68	37.3	0.0-5.2	" "
	K69	37.6	0.0-3.8	Brown SAND
	K76	37.2	0.0-1.5	Organic silty SAND
			1.5-3.0	Organic SILT & peat
	K77	39.2	0.0-1.7	Gravelly sandy SILT
	KE-1	40.3	0.0-5.0	Organic SILT w/shells
	KE-2	40.5	0.0-5.0	" " "
	KE-5	39.7	0.0-5.0	" " "

NOTES:
For general notes, see Sheet 2.
For symbols, probing and sample notes, see Sheet 2.

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY ALD | TR. BY ALD | CK. BY J.F.&P.M.

SUBMITTED: PROJECT ENGINEER

REVIEWED: CHIEF, ENG. & G. BRANCH

APPROVAL RECOMMENDED: CHIEF, ECON. ANL. BRANCH

FALL RIVER HARBOR
MASS. & R.I.
IMPROVEMENT DREDGING 40-FOOT CHANNELS
DESIGN MEMO-PROBINGS AND BORINGS

APPROVED: CHIEF, ENGINEERING DIVISION

DATE: AUGUST 1972

TO ACCOMPANY DESIGN MEMORANDUM DATED 21 AUGUST 1972

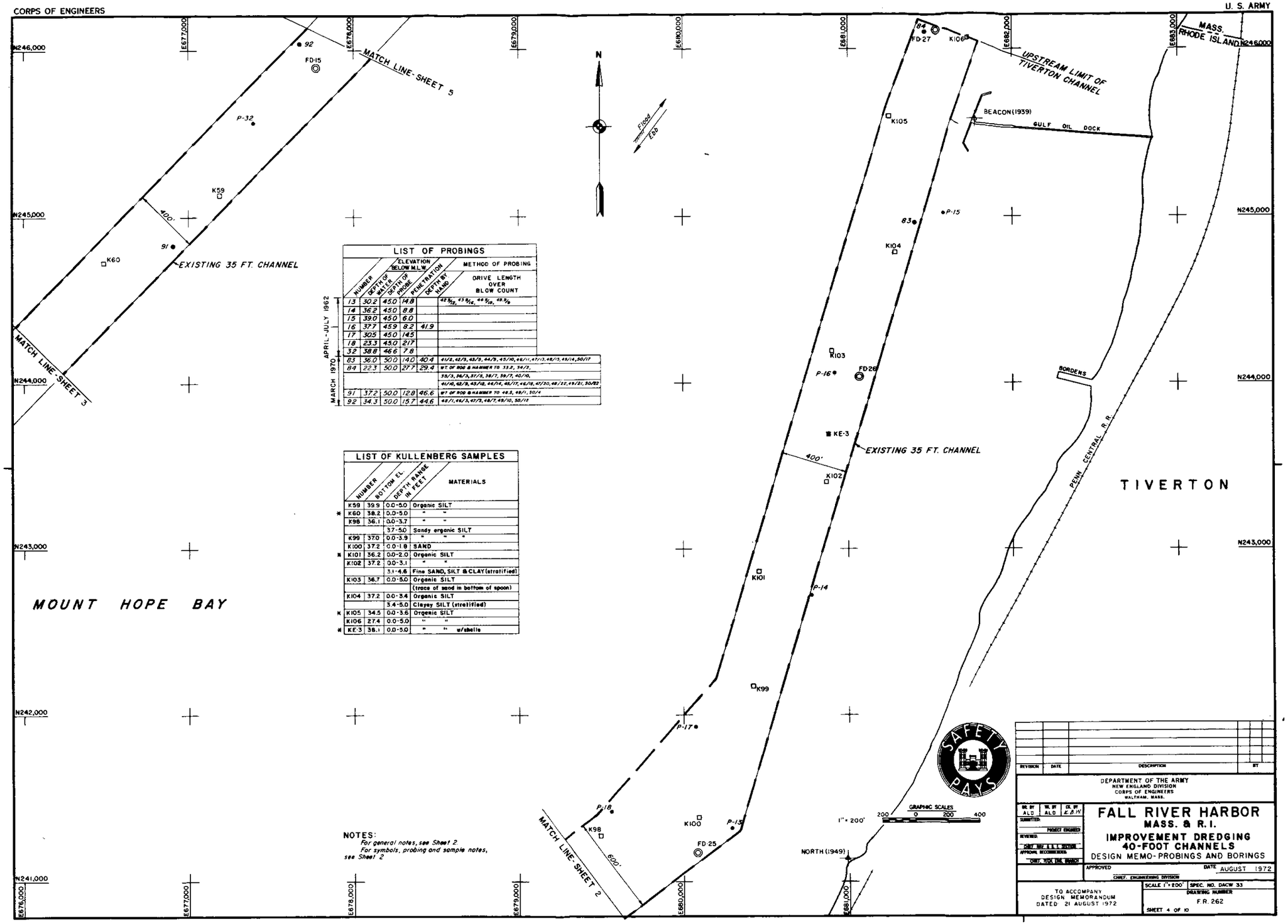
SCALE 1" = 200' | SPEC. NO. DACW 33

DRAWING NUMBER FR.262

SHEET 3 OF 10

CORPS OF ENGINEERS

U. S. ARMY



LIST OF PROBINGS

	Number	Elevation Below M.L.W. Depth of Water	Depth of Probe	Penetration Depth by Hand	Method of Probing: Drive Length over Blow Count
APRIL-JULY 1962	13	30.2	45.0	14.8	42 5/12, 43 5/16, 44 5/19, 45 3/8
	14	36.2	45.0	8.8	
	15	39.0	45.0	6.0	
	16	37.7	45.9	8.2	41.9
	17	30.5	45.0	14.5	
	18	23.3	45.0	21.7	
	32	38.8	46.6	7.8	
MARCH 1970	83	36.0	50.0	14.0	40.4 41/2, 42/3, 43/3, 44/3, 45/10, 46/11, 47/13, 48/15, 49/14, 50/17
	84	22.3	50.0	27.7	29.4 W.T. OF ROD & HAMMER TO 33.2, 34/3, 35/3, 36/3, 37/3, 38/7, 39/7, 40/10, 41/10, 42/9, 43/18, 44/14, 45/17, 46/18, 47/20, 48/22, 49/21, 50/22
	91	37.2	50.0	12.8	46.6 W.T. OF ROD & HAMMER TO 48.5, 49/1, 50/4
	92	34.3	50.0	15.7	44.6 48/1, 49/3, 47/3, 48/7, 49/10, 50/18

LIST OF KULLENBERG SAMPLES

	Number	Bottom El.	Depth Range in Feet	Materials
*	K59	39.9	0.0-5.0	Organic SILT
*	K60	38.2	0.0-5.0	" "
	K98	36.1	0.0-3.7	" "
			3.7-5.0	Sandy organic SILT
	K99	37.0	0.0-3.9	" " "
	K100	37.2	0.0-1.8	SAND
*	K101	36.2	0.0-2.0	Organic SILT
	K102	37.2	0.0-3.1	" "
			3.1-4.6	Fine SAND, SILT & CLAY (stratified)
	K103	36.7	0.0-5.0	Organic SILT (trace of sand in bottom of spoon)
	K104	37.2	0.0-3.4	Organic SILT
			3.4-5.0	Clayey SILT (stratified)
*	K105	34.5	0.0-3.6	Organic SILT
*	K106	27.4	0.0-5.0	" "
*	KE-3	38.1	0.0-5.0	" " w/shells

NOTES:
For general notes, see Sheet 2
For symbols, probing and sample notes, see Sheet 2

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY	TR. BY	CK. BY
ALD	ALD	E.B.W.

SUBMITTED: PROJECT ENGINEER
REVIEWED: CHIEF, REV. & E.A. SECTION
APPROVED, RECOMMENDED: CHIEF, TECH. ENG. BRANCH
APPROVED: CHIEF, ENGINEERING DIVISION
DATE AUGUST 1972

FALL RIVER HARBOR
MASS. & R.I.
IMPROVEMENT DREDGING 40-FOOT CHANNELS
DESIGN MEMO-PROBINGS AND BORINGS

TO ACCOMPANY DESIGN MEMORANDUM DATED 21 AUGUST 1972

SCALE 1"=200' SPEC. NO. DACW 33
DRAWING NUMBER F.R. 262
SHEET 4 OF 10

CORPS OF ENGINEERS

U. S. ARMY

N

E678,000 E679,000 E680,000 E681,000 E682,000 E683,000 E684,000 E685,000

N251,000 N250,000 N249,000 N248,000 N247,000

MASS. RHODE ISLAND

MATCH LINE-SHEET 6

MATCH LINE-SHEET 4

EXISTING 35 FT. CHANNEL

400'

Flood

Ebb

K53 K54 K55 K56 K57 K58

KE-6 KE-7

P-37 P-36 P-35 P-34 P-33 93

FD-13 FD-14

GAS (1939)

FALL RIVER GAS WORKS CO.

PENN CENTRAL R.R.

H.L. Mk. 2 (1939)

FALL RIVER

MOUNT HOPE BAY

LIST OF PROBINGS

NUMBER	DEPTH OF WATER	ELEVATION BELOW M.L.W. DEPTH OF PROBE	PENETRATION DEPTH BY HAND	METHOD OF PROBING DRIVE LENGTH OVER BLOW COUNT	
33	37.0	46.8	9.8		
34	38.8	46.2	7.4		
35	38.5	45.9	7.4		
36	39.4	45.0	5.6		
37	39.2	45.4	6.2		
93	36.5	50.0	13.5	44.4	40/12, 46/9, 41/5, 48/7, 49/10, 50/13

APRIL-JULY 1962

MARCH 1970

LIST OF KULLENBERG SAMPLES

NUMBER	BOTTOM EL.	DEPTH RANGE IN FEET	MATERIALS
K53	34.9	0.0-5.0	Organic SILT
K54	No Recovery	0.0-5.0	" "
K55		0.0-5.0	" "
* K56	37.7	0.0-5.0	" "
K57	38.4	0.0-5.0	" "
K58	38.1	0.0-5.0	" "
KE-6	38.7	0.0-5.0	" " w/shells
* KE-7	37.0	0.0-5.0	" " "

NOTES:
For general notes, see Sheet 2.
For symbols, probing and sample notes, see Sheet 2.

GRAPHIC SCALES
200 0 200 400
1" = 200'

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY	TR. BY	CK. BY
ALD	ALD	J.D.M.

SUBMITTED: PROJECT ENGINEER
REVIEWED: CHIEF, NAV. & H. H. SECTION
APPROVAL RECOMMENDED: CHIEF, TECH. ENG. BRANCH

FALL RIVER HARBOR
MASS. & R.I.
IMPROVEMENT DREDGING 40-FOOT CHANNELS
DESIGN MEMO-PROBINGS AND BORINGS

APPROVED: CHIEF, ENGINEERING DIVISION
DATE: AUGUST 1972

TO ACCOMPANY DESIGN MEMORANDUM DATED 21 AUGUST 1972

SCALE 1"=200' | SPEC. NO. DACW 33

DRAWING NUMBER F.R. 262

SHEET 5 OF 10

CORPS OF ENGINEERS

U. S. ARMY

N

MOUNT HOPE BAY

FALL RIVER

N.E. POWER CO. (Brayton Sta.) Approach channel (35' depth at M.L.W.) (PRIVATE)

300'

400'

EXISTING 35 FT. CHANNEL

MATCH LINE - SHEET 7

MATCH LINE SHEET 5

ATLANTIC (1939)

STAPLES COAL CO. (Globe Wharf)

PENN CENTRAL R.R.

Flood

Ebb

7 (1939)

P-38 P-39 P-40 P-41 P-42 P-43 P-44

94 95 96 97 98 99 100 101

K8 K9 K10 K11 K12 K13 K46 K47 K48 K49 K50 K51 K52 K107 K108 K109 K110 K111 K112 K113 K114 K115

KE-8 KE-9 KE-11

FD-9 FD-11 FD-12

N256,000 N255,000 N254,000 N253,000 N252,000

E683,000 E684,000 E685,000 E686,000 E687,000 E688,000

LIST OF PROBINGS

NUMBER	ELEVATION BELOW M.L.W. DEPTH OF WATER	DEPTH OF PROBE	PENETRATION DEPTH BY HAND	DRIVE LENGTH OVER BLOW COUNT	METHOD OF PROBING
38	38.7	46.0	7.3		
39	38.0	47.9	9.9		
40	37.9	46.8	8.9		
41	37.0	45.4	8.4		
42	38.0	45.0	7.0		
43	37.8	45.0	7.2	42.0	43 blows, 44 1/2", 45 0/5
44	37.7	49.7	12.0		
94	37.2	50.0	12.8	48.0	WT OF ROD & HAMMER TO 50.0
95	36.6	50.0	13.4	45.7	46/11, 47/4, 48/6, 49/6, 50/8
96	36.6	50.0	13.4	44.9	45/2, 46/4, 47/4, 48/7, 49/9, 50/13
97	35.8	50.0	14.2	47.2	48/3, 49/4, 50/6
98	35.6	50.0	14.4	45.4	46/3, 47/3, 48/7, 49/7, 50/10
99	37.0	50.0	13.0	46.1	47/12, 48/20, 49/19, 50/20
100	36.7	50.0	13.3	45.8	46/2, 47/6, 48/6, 49/8, 50/15
101	38.0	50.0	12.0	46.5	WT OF ROD & HAMMER TO 50.0

APRIL-JULY 1962

FEB-APR 1970

LIST OF KULLENBERG SAMPLES

	NUMBER	BOTTOM EL.	DEPTH RANGE IN FEET	MATERIALS
	K8	37.6	0.0-5.0	Dk. brown, organic SILT, w/odor & shell fragments
	K9	35.5	0.0-5.0	Black, loose organic SILT
	K10	38.5	0.0-5.0	Dk. brown, organic SILT, w/odor, shells & one starfish
	K11	38.2	0.0-3.5	Dk. brown, loose organic SILT
			3.5-4.8	Brown, gravelly sandy SILT
N	K12	38.2	0.0-4.8	Dk. brown, loose organic SILT w/odor & shell fragments
	K13	37.4	0.0-1.1	Dk. brown sandy organic SILT
			1.1-4.9	Dk. gray organic silty SAND w/odor
	K46	26.7	0.0-5.0	Organic SILT
	K47	35.2	0.0-1.0	" "
			1.0-4.4	Med. fine SAND
	K48	36.0	0.0-3.3	SAND w/shells
	K49	37.0	0.0-4.1	Organic SILT
	K50	36.3	0.0-5.0	" "
	K51	35.2	0.0-4.7	" "
*	K52	39.2	0.0-5.0	" "
	K107	36.6	0.0-1.9	SAND
	K108	37.0	0.0-5.0	Organic SILT
	K109	36.6	0.0-3.2	SAND w/shells
	K110	37.2	0.0-3.0	SAND w/trace of GRAVEL
	K111	38.1	0.0-3.4	SAND
	K112	38.0	0.0-3.0	"
	K113	38.0	0.0-2.9	"
	K114	36.8	0.0-3.1	Sandy organic SILT
			3.1-5.0	SAND w/shells
	K115	36.1	0.0-2.7	SAND
	KE-8	39.5	0.0-5.0	Organic clayey SILT w/shells
	KE-9	38.5	0.0-5.0	" " " "
	KE-11	38.4	0.0-5.0	" " " "

NOTES:
For general notes, see Sheet 2.
For symbols, probing and sample notes, see Sheet 2

GRAPHIC SCALES
1" = 200'
200 0 200 400

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY	TR. BY	CH. BY
ALD	ALD	EEK

SUBMITTED: PROJECT ENGINEER
REVIEWED: CHIEF, BRH. A & E. SECTION
APPROVAL RECOMMENDED: CHIEF, TECH. ENG. BRANCH

FALL RIVER HARBOR
MASS. & R.I.
IMPROVEMENT DREDGING
40-FOOT CHANNELS
DESIGN MEMO-PROBINGS AND BORINGS

APPROVED: CHIEF, ENGINEERING DIVISION
DATE: AUGUST 1972

TO ACCOMPANY
DESIGN MEMORANDUM
DATED 21 AUGUST 1972

SCALE 1"=200' | SPEC. NO. DACW 33
DRAWING NUMBER
FR 262
SHEET 6 OF 10

CORPS OF ENGINEERS

U. S. ARMY

SOMERSET

FALL RIVER

FALL RIVER HARBOR

30' CHANNEL

Proposed future pier - 50' x 1300' (Montaup Elect. Co.)

BERTH

BERTH

Montaup Elect. Co. Future approach channel

SEWAMMOCK (1939) (U.S.C.&G.S. 1934)

DRILL HOLE (1939)

FALL RIVER ELECTRIC LIGHT CO.

PENN CENTRAL R. R.

COOK BORDEN LUMBER CO.

CITY PIER

CITY WHARF

MATCH LINE - SHEET 8

600'

500'

EXISTING 35' CHANNEL

25' ANCHORAGE

30' CHANNEL

BRAGA

BRIDGE

BRAGA BRIDGE (FIXED)
Hor. Cl. 400' (Full channel width)
Vert. Cl. 136' above M.H.W.

PACIFIC TERMINAL CITIES SERVICE

H.L. No. 5 (1940)

W.C. ATWATER & CO. INC.

APPROX. PROPOSED DIKE LINE

BATTLESHIP MASSACHUSETTS

STAPLES COAL CO.

STATE PIER

J.A. BOWEN CO.

KEOUGH STORAGE CO.

Fixed Edg

400'

E(1939)

EXISTING 35' CHANNEL

FIRESTONE RUBBER & LATEX PRODUCTS CO.

MATCH LINE - SHEET 6

CURRAN AND BURTON

7 (1939)

K29 K30 K31 K32 K33 K34 K35 K36 K37 K38 K39 K40 K41 K42 K43 K44 K45 FD-7 FD-6 KE-10 P-45 P-46

N260,000 N259,000 N258,000 N257,000 N256,000

E688,000 E689,000 E690,000 E691,000 E692,000 E693,000 E694,000

GRAPHIC SCALES
1" = 200'
200 0 200 400

NOTES:
For general notes, see Sheet 2.
For symbols, probing and sample notes, see Sheet 2.

SAFETY PAYS

LIST OF PROBINGS

	NUMBER	DEPTH OF WATER	ELEVATION BELOW M.L.W. DEPTH OF PROBE	PENETRATION	METHOD OF PROBING: DEPTH BY HAND	DRIVE LENGTH OVER BLOW COUNT
APRIL - JULY 1962	45	37.7	46.7	9.0		
	46	30.6	46.1	15.5		
	103	36.9	50.0	13.1	44.8	WT. OF HAMMER & ROD TO 48.3, 49/2, 50/4
	103	37.2	50.0	12.8	46.5	47/1, 48/2, 49/4, 50/4
	104	36.5	50.0	13.5	38.0	39/4, 40/5, 41/7, 42/7, 43/9, 44/8, 46/10, 48/11, 47/13, 48/15, 49/15, 50/13
	105	36.6	50.0	13.4	37.4	38/7, 38/15, 40/17, 41/15, 42/16, 43/16, 44/18, 45/18, 46/12, 47/10, 48/11, 49/10, 50/10
	106	37.0	50.0	13.0	43.4	BLOW COUNT NOT AVAILABLE
	107	36.4	50.0	13.6	43.1	44/8, 45/7, 46/7, 47/9, 48/8, 49/10, 50/8
	108	36.5	50.0	13.5	37.1	38/4, 39/4, 40/8, 41/7, 42/8, 43/10, 44/11, 45/10, 46/9, 47/10, 48/11, 49/11, 50/10
	109	37.9	50.0	12.1	38.5	39/8, 40/9, 41/12, 42/19, 43/24, 44/48, 45/54, 46/52, 47/30, 48/25, 49/40, 50/38
	110	36.4	50.0	13.6	38.0	39/9, 40/16, 41/19, 42/22, 43/20, 44/19, 45/21, 46/24, 47/22, 48/20, 49/46, 50/34
	111	37.3	50.0	12.7	37.8	38/1, 39/4, 40/6, 41/8, 42/8, 43/12, 44/16, 45/16, 46/17, 47/19, 48/20, 49/20, 50/22
	112	36.7	50.0	13.3	38.5	39/3, 40/7, 41/7, 42/9, 43/10, 44/11, 45/9, 46/11, 47/8, 48/14, 49/16, 50/48
	113	36.6	50.0	13.4	38.4	39/9, 40/8, 41/7, 42/8, 43/7, 44/8, 45/10, 46/12, 47/14, 48/16, 49/16, 50/20
	114	37.0	50.0	13.0	38.7	39/1, 40/4, 41/6, 42/7, 43/8, 44/8, 45/9, 46/13, 47/15, 48/13, 49/19, 50/22
	115	38.1	50.0	11.9	39.7	40/2, 41/6, 42/16, 43/22, 44/29, 45/83, 46/59, 47/36, 48/26, 49/29, 50/32
	116	38.4	50.0	11.6	39.1	40/4, 41/8, 42/8, 43/9, 44/7, 45/9, 46/11, 47/11, 48/14, 49/19, 50/17
	117	37.4	50.0	12.6	38.8	39/1, 40/3, 41/8, 42/8, 43/8, 44/8, 45/12, 46/14, 47/16, 48/18, 49/17, 50/17
	118	38.5	50.0	11.5	40.5	41/9, 42/5, 43/8, 44/5, 45/8, 46/10, 47/12, 48/11, 49/13, 50/17
	119	37.4	50.0	12.6	40.7	41/8, 42/4, 43/4, 44/7, 45/7, 46/9, 47/11, 48/14, 49/14, 50/16
	120	35.9	50.0	14.1	41.1	42/4, 43/6, 44/6, 45/7, 46/8, 47/10, 48/14, 49/17, 50/22
	121	37.9	50.0	12.1	40.3	41/7, 42/5, 43/8, 44/6, 45/8, 46/10, 47/14, 48/12, 49/16, 50/16
	122	37.2	50.0	12.8	39.0	40/5, 41/4, 42/6, 43/6, 44/8, 45/12, 46/10, 48/13, 48/16, 49/14, 50/19
	123	35.3	50.0	14.7	38.3	39/6, 40/7, 41/7, 42/9, 43/14, 44/19, 45/20, 46/22, 47/24, 48/21, 49/23, 50/26

LIST OF KULLENBERG SAMPLES

NUMBER	BOTTOM EL.	DEPTH RANGE IN FEET	MATERIALS
K29	37.5	0.0-0.7	Gravelly sandy SILT
K30	31.4	0.0-4.8	Organic SILT
K31	35.0	0.0-4.8	" "
K32	38.3	0.0-5.0	" "
K33	37.4	0.0-2.0	" "
		2.0-3.8	Sandy GRAVEL
K34	37.3	0.0-0.6	Med. fine SAND
		0.6-1.0	Gravelly SAND
K35	37.3	0.0-5.0	Organic SILT. Trace of GRAVEL
K36	38.0	0.0-1.2	Gravelly SAND
K37			No record
K38	37.8	0.0-0.6	Sandy GRAVEL
K39	39.4	0.0-5.0	Organic SILT
K40	37.8	0.0-2.1	Gravelly sandy organic SILT
		2.1-3.7	Silty sandy GRAVEL
K41	37.5	0.0-5.0	Organic SILT
K42	39.2	0.0-5.0	" "
K43	36.8	0.0-5.0	" "
K44	38.5	0.0-5.0	" "
K45	36.6	0.0-3.6	" "
		3.6-5.0	Organic silty SAND
KE-10	38.3	0.0-5.0	Organic clayey SILT w/shells

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY	TR. BY	CK. BY
ALO	ALO	K.B.V.

SUBMITTED: PROJECT ENGINEER

REVIEWED: CHIEF, ENGR. DATA BRANCH

CHIEF, ENGINEERING DIVISION

FALL RIVER HARBOR
MASS. & R.I.
IMPROVEMENT DREDGING 40-FOOT CHANNELS
DESIGN MEMO - PROBINGS AND BORINGS

APPROVED DATE AUGUST 1972

TO ACCOMPANY DESIGN MEMORANDUM DATED 21 AUGUST 1972

SCALE 1"=200' SPEC. NO. DACW 33

DRAWING NUMBER FR 262

SHEET 7 OF 10

CORPS OF ENGINEERS

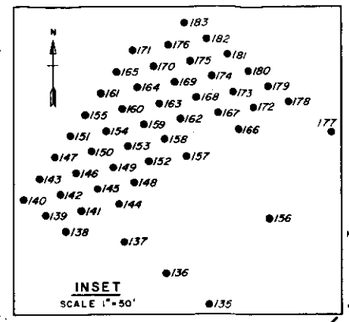
U. S. ARMY

LIST OF PROBINGS

NUMBER	ELEVATION BELOW M.L.W. DEPTH OF WATER	DEPTH OF PROBE	METHOD OF PROBING PENETRATION	DRIVE LENGTH BY HAND	DRIVE LENGTH OVER BLOW COUNT
47	31.6	49.8	18.2		
48	36.8	46.4	9.6		
49	32.3	46.1	13.8		
50	25.6	46.9	21.3		
51	32.8	47.0	14.2		
52	30.6	46.0	15.4		
53	39.6	45.0	5.4	42.3	43.5/18, 46.5/16, -/0/16
54	34.5	45.0	10.5	36.4	37/16, 35/22, 39/33, 40/33, 41/20, 42/13
					43/19, 44/20, 46/23
124	36.7	50.0	13.3	40.4	41/9, 42/22, 43/30, 44/49, 45/34, 46/32, 47/30, 48/14, 49/10, 50/17
125	33.1	50.0	16.9	42.0	43/8, 44/10, 46/15, 46/11, 47/10, 48/17, 49/16, 50/17
126	38.0	50.0	12.0	47.4	WT OF 300 & HAMMER TO 50.0
127	31.1	50.0	18.9	47.4	46/8, 49/7, 50/14
128	31.8	50.0	18.2	42.7	43/3, 44/7, 45/8, 46/15, 47/15, 48/20, 49/23, 50/24
129	36.4	49.3	12.9	39.0	40/12, 41/28, 42/42, 43/72, 44/42, 45/150, 46/94, 47/82, 48/89, 49/82, 49/110 REF
130	38.1	50.0	11.9	46.7	47/11, 48/49, 49/17, 50/84
131	37.4	50.0	12.6	45.8	46/8, 47/36, 48/84, 49/74, 50/79
132	37.1	48.6	11.5	46.5	49/12, 48/84, 48.8/115, 48.6/100 REF.
133	32.6	47.5	14.9	41.2	42/34, 43/115, 44/117, 45/154, 46/138, 47/186, 47.5/170, 47.5/100 REF
134	36.6	48.1	11.5	44.2	45/16, 46/68, 47/85, 48/142, 48.1/80, 48.1/100, REF.
135	38.3	50.0	11.7	42.0	43/16, 44/24, 45/30, 46/29, 47/16, 48/110, 49/182, 50/172
136	39.2	49.2	10.0	42.7	43/7, 44/22, 45/29, 46/37, 47/54, 48/160, 49/196, 49.2/232, 49.2/100 REF.
137	37.6	44.2	6.6	38.1	39/26, 40/80, 41/78, 42/118, 43/184, 44/241,
					44.2/270, 44.2/200, REF.
138	37.7	42.7	5.0	40.5	41/4, 42/70, 42 1/24, 42.7/100, REF.
139	30.0	35.4	5.4	32.6	33/2, 34/13, 35/36, 35.4/36, 35.4/100, REF.
140	18.0	31.6	13.6	20.6	21/8, 22/24, 23/33, 24/41, 25/70, 26/79, 27/82,
					28/85, 29/90, 30/118, 31/92, 31.6/90, 31.6/100, REF
141	29.2	44.1	14.9	29.4	30/34, 31/38, 32/45, 33/57, 34/99, 35/140, 36/131,
					37/139, 38/216, 39/244, 40/250, 41/290, 42/315,
					43/322, 44/350, 44.1/210
142	29.6	38.4	8.8	34.4	35/8, 36/22, 37/48, 38/75, 38.4/50, 38.4/100, REF
143	17.1	28.0	12.9	18.0	19/6, 20/11, 21/29, 22/35, 23/51, 24/46, 25/54
					26/67, 27/72, 28/90, 28/100, REF.
144	38.1	43.1	5.0	41.1	42/8, 43/34, 43.1/4, 43.1/100, REF.
145	37.5	42.0	4.5	40.1	41/14, 42/100, REF.
146	28.6	32.3	3.7	30.6	31/2, 32/24, 32.3/8, 32.3/100, REF.
147	16.5	26.2	9.7	20.1	21/10, 22/16, 22.3/16, 23/30, 24/39, 25/44,
					26/62, 26.2/80, 26.2/100, REF.
148	38.4	43.7	5.3	41.1	42/8, 43/22, 43.7/84, 43.7/100, REF.
149	36.8	40.9	4.1	40.6	40.9/1, 40.9/100, REF.
150	28.0	36.2	7.8	31.6	32/11, 33/19, 34/32, 35/49, 36/37, 36.2/14,
					36.2/100, REF.
151	16.4	25.9	9.5	18.9	19/1, 20/17, 21/19, 22/24, 23/22, 24/38, 25/42,
					25.8/42, 25.9/100, REF.
152	39.0	42.7	3.7	40.8	41/1, 42/11, 42.7/30, 42.7/100, REF.
153	37.2	40.8	3.6	38.3	39/3, 40/10, 40.8/14, 40.8/100, REF.
154	27.4	31.3	3.9	29.1	30/4, 31/8, 31.3/28, 31.3/100, REF.
155	17.1	23.5	6.4	20.9	21/1, 22/4, 23/16, 23.5/22, 23.5/100, REF.
156	38.5	50.0	11.5	42.2	43/10, 44/24, 45/31, 46/41, 47/34, 48/16, 49/16, 50/84
157	38.6	43.5	4.9	41.0	42/8, 43/28, 43.5/34, 43.5/100, REF.
158	39.1	43.6	4.5	41.1	42/14, 43/38, 43.6/80, 43.6/100, REF.
159	38.5	40.9	2.4	40.1	40.9/10, 40.9/100, REF.
160	31.3	37.3	6.0	35.0	36/8, 37/15, 37.3/7, 37.3/100, REF.
161	22.0	24.4	2.4	22.6	23/1, 24/7, 24.4/18, 24.4/100, REF.
162	39.4	42.2	2.8	41.2	42/8, 42.2/10, 42.2/100, REF.
163	36.8	41.0	4.2	41.0	41/11, 41/100, REF
164	32.3	36.9	4.6	34.9	35/1, 34/4, 36.9/7, 36.9/100, REF
165	21.2	24.1	1.9	23.1	24/10, 24.1/18, 24.1/100, REF
166	39.4	44.3	4.9	41.8	42/8, 43/14, 44/34, 44.3/28, 44.3/100, REF.
167	39.8	43.4	3.6	41.5	42/16, 43/48, 43.4/36, 43.4/100, REF.
168	38.1	43.0	4.9	41.3	42/28, 43/48, 43/100, REF.
169	33.6	38.2	4.6	35.1	36/2, 37/4, 38/3, 38.2/10, 38.2/100, REF.
170	15.1	22.6	7.5	16.1	17/3, 18/3, 19/6, 20/7, 21/12, 22/19,
					22.6/29, 22.6/100, REF.
171	14.0	23.8	9.8	17.4	18/3, 19/3, 20/4, 21/8, 22/10, 23/28,
					23.8/28, 23.8/100, REF.
172	39.1	44.4	5.3	40.9	42/27, 43/135, 44/148, 44.4/86, 44.4/100, REF.
173	38.1	41.5	3.4	40.8	41/11, 41.5/5, 41.5/100, REF.
174	37.3	41.4	4.1	41.4	41.4/100, REF.
175	29.0	31.8	2.8	31.8	31.8/100, REF
176	15.6	22.4	6.8	17.8	18/4, 19/32, 20/57, 21/102, 22/135, 22.4/190,
					22.4/100, REF.
177	38.4	47.0	8.6	44.4	45/10, 46/44, 47/50, 47.1/148, 47.1/100, REF.
178	38.9	45.0	6.1	40.6	41/4, 42/8, 43/22, 44/34, 45/66, 45/100, REF
179	39.0	44.9	5.9	40.9	41/1, 42/7, 43/14, 44/38, 44.9/35, 44.9/100, REF.
180	37.4	42.1	4.7	40.2	41/4, 42/19, 42.1/4, 42.1/100, REF.
181	36.3	41.5	5.2	41.5	41.5/100, REF
182	29.0	34.3	5.3	33.3	34/16, 34.3/13, 34.3/100, REF.
183	15.6	22.3	6.7	17.3	18/11, 19/29, 20/44, 21/87, 22/105, 22.3/146,
					22.3/100, REF.
184	38.1	50.0	11.9	45.7	46/1, 47/8, 48/41, 49/109, 50/146
185	35.9	48.1	12.2	42.1	43/29, 44/57, 45/70, 46/84, 47/125, 48/230, 48 1/110
186	35.9	47.4	11.5	40.6	41/9, 42/26, 43/39, 44/56, 45/85, 46/87, 47/134, 47.4/190, 47.4/100 REF
187	38.5	50.0	11.5	42.7	43/1, 44/3, 45/5, 46/18, 47/24, 48/39, 49/85, 50/109
188	37.9	50.0	12.1	40.2	41/4, 42/18, 43/15, 44/15, 45/24, 46/29, 47/34, 48/38, 49/46, 50/47
189	37.5	50.0	12.5	44.2	45/2, 46/7, 47/19, 48/30, 49/38, 50/46
190	38.5	45.3	6.8	44.4	45/2, 45.3/90, VIC. 8" WATER MAIN
191	37.9	50.0	12.1	44.2	45/2, 46/7, 47/9, 48/28, 49/35, 50/59

APRIL - JULY 1962

FEBRUARY - APRIL 1970



LIST OF KULLENBERG SAMPLES

NUMBER	BOTTOM EL.	DEPTH RANGE IN FEET	MATERIALS
K14	47.7	0.0-1.1	Dk. gray silty SAND
		1.1-4.2	Dk. gray sandy gravelly SILT
K15	38.6	0.0-1.1	Gray silty sandy GRAVEL
K16	38.5	0.0-0.9	Black sandy organic SILT
		0.9-1.3	Dk. gray, silty sandy GRAVEL
K17	38.0	0.0-4.0	Black, loose organic SILT
		4.0-5.0	Black gravelly silty SAND
K18	41.7	0.0-5.0	Dk. brown organic SILT w/odor & shells
* K19	31.6	0.0-3.4	Dk. brown, very loose organic SILT
K20	38.5	0.0-5.0	Dk. brown organic SILT w/odor & shells
K21	38.5	0.0-5.0	" " " " " "
K22	32.6	0.0-4.1	Black organic SILT
		4.1-5.0	Gray silty gravelly SAND
K23	38.4	0.0-2.0	Med fine SAND, trace of gravel
K24	38.1	0.0-2.6	Brown, med. fine SAND
K25	30.6	0.0-4.2	Black organic SILT w/0.1' layer of SAND
K26	38.4		Lost sample
* K27	34.2	0.0-4.6	Organic SILT
K28	37.5	0.0-2.0	Silty fine SAND
KE-12	38.2	0.0-5.0	Organic clayey SILT w/shells

LIST OF PROBINGS

CROSS RANGE	HEAD RANGE	ELEVATION BELOW M.L.W. DEPTH OF WATER	DEPTH OF PROBE	METHOD OF PROBING PENETRATION	DRIVE LENGTH BY HAND	DRIVE LENGTH OVER BLOW COUNT
0+50	0+50	43.9				
	1+00	40.0	42.0	2.0	42.0	
	1+50	40.1	42.0	1.9	42.0	
	2+00	39.7	42.0	4.3	42.0	
	2+50	40.4	42.0	1.6	42.0	
	3+00	39.1	43.5	4.4	43.5	
	3+50	30.4	42.0	11.6	37.8	39/2, 40/14, 41/4, 42/4
1+00	0+50	42.8				
	1+00	35.6	42.0	6.4	42.0	
	1+50	35.1	42.0	6.9	39.0	40/16, 41/12, 42/10
	2+00	34.9	42.0	7.1	42.0	
	2+50	33.7	42.0	8.3	42.0	
	3+00	35.5	42.0	6.5	41.2	42/2
	3+50	35.6	42.0	6.4	41.8	42/2
1+50	0+50	40.5	42.0	1.5	42.0	
	1+00	34.5	42.0	7.5	42.0	
	1+50	29.3	38.1	8.8	35.7	37/29, 38/60, 38.1/100, REF.
	2+00	29.5	42.0	12.5	40.0	41/2, 42/3
	2+50	29.7	42.0	12.3	37.0	38/8, 39/9, 40/6, 41/8, 42/7
	3+00	34.4	42.0	7.6	37.7	38/3, 39/3, 40/10, 41/16, 42/24
	3+50	37.8	42.0	4.2	42.0	
2+00	0+50	43.9				
	1+00	44.0				
	1+50	34.8	42.0	7.2	39.0	40/4, 41/4, 42/1
	2+00	33.6	42.0	8.4	39.0	40/3, 41/3, 42/4
	2+50	33.1	42.0	8.9	41.0	42/2
	3+00	32.5	42.0	9.5	35.0	36/3, 37/4, 38/3, 39/1, 40/1, 41/1, 42/1
	3+50	38.6	42.0	3.4	42.0	

NOTE:
Probings are from survey of Mar. 14, 1972 by H. Fishlock.
Field books: R.B.H. 966, 1336 & 3005.

NOTES:
For general notes, see Sheet 2.
For symbols, probing and [illegible] notes, see Sheet 2.

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY	TR. BY	CK. BY
ALD	ALD	E.A.M.

SUBMITTED: PROJECT ENGINEER
REVIEWED: CHIEF, NAV. & R. E. SECTION
APPROVAL RECOMMENDED: CHIEF, TECH. ENG. BRANCH
APPROVED: CHIEF, ENGINEERING DIVISION
DATE AUGUST 1972

FALL RIVER HARBOR
MASS. & R.I.
IMPROVEMENT DREDGING 40-FOOT CHANNELS
DESIGN MEMO-PROBINGS AND BORINGS

TO ACCOMPANY DESIGN MEMORANDUM DATED 21 AUGUST 1972

SCALE 1"= 200' | SPEC. NO. DACW 33
DRAWING NUMBER F.R. 262

SHEET 8 OF 10

CORPS OF ENGINEERS — U. S. ARMY

APRIL - JULY 1962

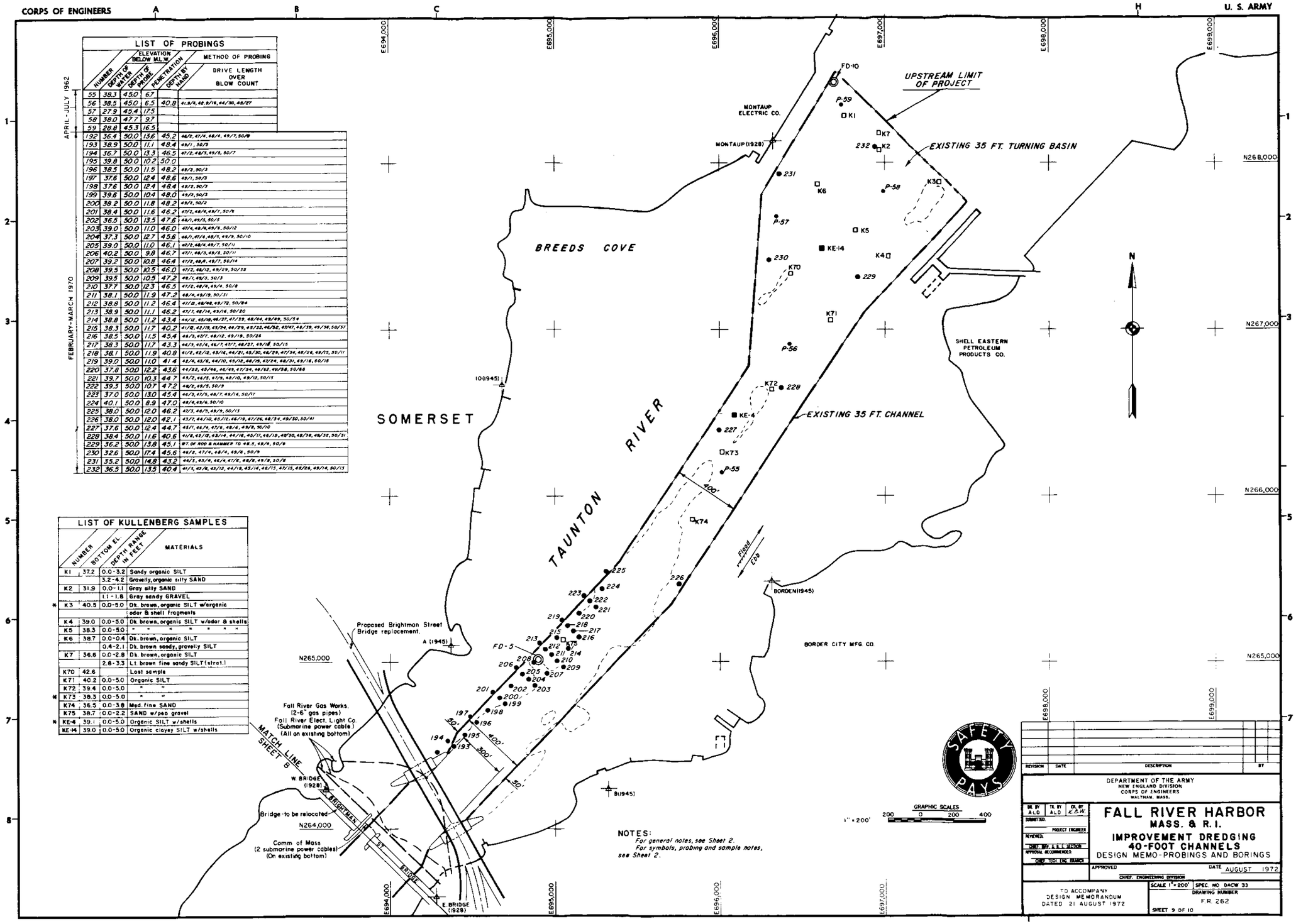
FEBRUARY - MARCH 1970

LIST OF PROBINGS

NUMBER	DEPTH OF WATER	ELEVATION BELOW M.L.W. DEPTH OF PROBE	PENETRATION DEPTH BY HAND	METHOD OF PROBING: DRIVE LENGTH OVER BLOW COUNT
55	38.3	45.0	6.7	
56	38.5	45.0	6.5	40.8 41.5/4, 42.5/15, 44/30, 45/27
57	27.9	45.4	17.5	
58	38.0	47.7	9.7	
59	28.8	45.3	16.5	
192	36.4	50.0	13.6	45.2 46/9, 47/4, 48/4, 49/7, 50/8
193	38.9	50.0	11.1	48.4 49/1, 50/5
194	36.7	50.0	13.3	46.5 47/2, 48/3, 49/5, 50/7
195	39.8	50.0	10.2	50.0
196	38.5	50.0	11.5	48.2 49/2, 50/5
197	37.6	50.0	12.4	48.6 49/1, 50/5
198	37.6	50.0	12.4	48.4 49/2, 50/5
199	39.6	50.0	10.4	48.0 49/2, 50/3
200	38.2	50.0	11.8	48.2 49/2, 50/2
201	38.4	50.0	11.6	46.2 47/2, 48/4, 49/7, 50/6
202	36.5	50.0	13.5	47.6 48/1, 49/3, 50/5
203	39.0	50.0	11.0	46.0 47/4, 48/4, 49/5, 50/12
204	37.3	50.0	12.7	45.6 46/1, 47/4, 48/5, 49/9, 50/10
205	39.0	50.0	11.0	46.1 47/2, 48/4, 49/7, 50/11
206	40.2	50.0	9.8	46.7 47/1, 48/3, 49/3, 50/11
207	39.2	50.0	10.8	46.4 47/2, 48/2, 49/7, 50/14
208	39.5	50.0	10.5	46.0 47/2, 48/12, 49/29, 50/35
209	39.5	50.0	10.5	47.2 48/1, 49/3, 50/3
210	37.7	50.0	12.3	46.5 47/2, 48/9, 49/4, 50/8
211	38.1	50.0	11.9	47.2 48/4, 49/19, 50/31
212	38.8	50.0	11.2	46.4 47/12, 48/48, 49/72, 50/84
213	38.9	50.0	11.1	46.2 47/7, 48/14, 49/16, 50/20
214	38.8	50.0	11.2	43.4 44/12, 45/18, 46/27, 47/39, 48/44, 49/69, 50/54
215	38.3	50.0	11.7	40.2 41/8, 42/18, 43/24, 44/29, 45/35, 46/52, 47/47, 48/39, 49/36, 50/37
216	38.5	50.0	11.5	45.4 46/3, 47/7, 48/12, 49/19, 50/26
217	38.3	50.0	11.7	43.3 46/3, 47/4, 48/7, 49/7, 48/27, 49/18, 50/15
218	38.1	50.0	11.9	40.8 41/8, 42/18, 43/16, 44/21, 45/30, 46/29, 47/34, 48/26, 49/15, 50/11
219	39.0	50.0	11.0	41.4 42/4, 43/6, 44/10, 45/18, 46/28, 47/24, 48/31, 49/16, 50/15
220	37.8	50.0	12.2	43.6 44/23, 45/46, 46/45, 47/34, 48/32, 49/58, 50/66
221	39.1	50.0	10.3	44.7 45/2, 46/5, 47/5, 48/10, 49/13, 50/15
222	39.3	50.0	10.7	47.2 46/2, 47/5, 50/9
223	37.0	50.0	13.0	45.4 46/3, 47/5, 48/7, 49/14, 50/17
224	40.1	50.0	8.9	47.0 48/4, 49/6, 50/10
225	38.0	50.0	12.0	46.2 47/3, 48/5, 49/9, 50/13
226	38.0	50.0	12.0	42.1 43/7, 44/10, 45/12, 46/19, 47/26, 48/34, 49/30, 50/41
227	37.6	50.0	12.4	44.7 45/1, 46/6, 47/5, 48/6, 49/8, 50/10
228	38.4	50.0	11.6	40.6 41/8, 42/13, 43/14, 44/16, 45/17, 46/19, 47/30, 48/36, 49/32, 50/31
229	36.2	50.0	13.8	45.1 BT. OF ROD & HAMMER TO 48.5, 49/4, 50/6
230	32.6	50.0	17.4	45.6 46/2, 47/4, 48/4, 49/6, 50/9
231	35.2	50.0	14.8	43.2 44/3, 45/8, 46/4, 47/6, 48/8, 49/8, 50/8
232	36.5	50.0	13.5	40.4 41/5, 42/6, 43/12, 44/19, 45/14, 46/15, 47/15, 48/26, 49/14, 50/13

LIST OF KULLENBERG SAMPLES

	NUMBER	BOTTOM EL.	DEPTH RANGE IN FEET	MATERIALS
	K1	37.2	0.0-3.2	Sandy organic SILT
			3.2-4.2	Gravelly, organic silty SAND
	K2	31.9	0.0-1.1	Gray silty SAND
			1.1-1.8	Gray sandy GRAVEL
*	K3	40.5	0.0-5.0	Dk. brown, organic SILT w/organic
				odor & shell fragments
	K4	39.0	0.0-5.0	Dk. brown, organic SILT w/odor & shells
	K5	38.3	0.0-5.0	" " " " " " "
	K6	38.7	0.0-0.4	Dk. brown, organic SILT
			0.4-2.1	Dk. brown sandy, gravelly SILT
	K7	36.6	0.0-2.8	Dk. brown, organic SILT
			2.8-3.3	Lt. brown fine sandy SILT(strat.)
	K70	42.6		Lost sample
	K71	40.2	0.0-5.0	Organic SILT
	K72	39.4	0.0-5.0	" "
*	K73	38.3	0.0-5.0	" "
	K74	36.5	0.0-3.8	Med. fine SAND
	K75	38.7	0.0-2.2	SAND w/pea gravel
*	KE-4	39.1	0.0-5.0	Organic SILT w/shells
	KE-14	39.0	0.0-5.0	Organic clayey SILT w/shells



NOTES:
For general notes, see Sheet 2.
For symbols, probing and sample notes, see Sheet 2.

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY	TR. BY	CH. BY
A.L.D.	A.L.D.	A.E.S.W.

SUBMITTED: PROJECT ENGINEER
REVIEWED: CHIEF, ENGR. & O. SECTION
APPROVAL RECOMMENDED: NEW. TECH. ENG. BRANCH
APPROVED: CHIEF, ENGINEERING DIVISION
DATE: AUGUST 1972

FALL RIVER HARBOR
MASS. & R.I.
IMPROVEMENT DREDGING 40-FOOT CHANNELS
DESIGN MEMO-PROBINGS AND BORINGS

TO ACCOMPANY DESIGN MEMORANDUM DATED 21 AUGUST 1972

SCALE 1" = 200' | SPEC. NO. DACW 33
DRAWING NUMBER F.R. 262
SHEET 9 OF 10

CORPS OF ENGINEERS — U. S ARMY

DEPTH IN FEET

FD-1
NOV. 1953
El. -30.8' M.L.W.
- 110 / 115 / 117 / 130 / 140 — SM — Silty, gravelly SAND (Glacial TILL)
- 49 / 45 / 41 / 40 / 33

FD-2
NOV. 1953
El. -28.7' M.L.W.
- 30 / 32 / 29 / 22 / 20 / 10 — SM — Gravelly, silty SAND (Glacial TILL)
- 11 / 13 / 17 / 14 / 15 / 14

FD-3
NOV. 1953
El. -30.5' M.L.W.
- 10 / 14 / 23 / 33 / 43 / 62 / 74 / 97 — SM — Silty, gravelly SAND (Glacial TILL)

FD-4
NOV. 1953
El. -32.1' M.L.W.
- 16 / 27 / 28 / 15 — GM — Silty, sandy GRAVEL (Glacial TILL)
- 16 / 13 / 12 / 24 — SM — Silty, gravelly SAND (Glacial TILL)

FD-5
NOV. 1953
El. -31.9' M.L.W.
- 20 / 18 / 10 / 14 / 16 / 16 / 13 — SM — Gravelly, silty SAND

FD-6
JUNE 10 1970
El. -39.0' M.L.W.
- 4 / 12 / 21 / 23 / 36 / 27 / 7 / 11 / 13 / 15 / 14 — GP/GM — Silty, sandy GRAVEL
- 20 / 20 / 27 / 22 — SP — SAND with oil streak trace of gravel
- SM — Silty SAND (STRATIFIED)

FD-7
JUNE 11 1970
El. -38.0' M.L.W.
- 0 / 10 / 14 / 9 / 11 / 10 / 16 / 15 / 14 / 11 / 13 / 16 / 17 / 15 / 16 — ML — Fine, sandy SILT trace of black sand a 0.6' — Fine, sandy SILT (STRATIFIED)

FD-8
JUNE 12 1970
El. -34.7' M.L.W.
- 5 / 20 — GP — Sandy GRAVEL with trace of silt
- Sandy organic SILT
- 4 — OH — Organic SILT w.t. trace of shells and coal
- 4 / 3 / 2

FD-9
JUNE 12 1970
El. -37.2' M.L.W.
- Organic SILT
- OH — Organic SILT plastic with fine trace of sand and occ. shell fragments
- 2/0 — SM — Silty, fine SAND with shells
- OH — Org. c SILT plastic with shells

FD-10
JUNE 15 1970
El. -28.5' M.L.W.
- OH — Organic SILT with traces of fibrous vegetation
- Organic SILT with shells
- Organic SILT with trace of fibers

FD-11
JUNE 14 1970
El. -37.6' M.L.W.
- 0 / 6 / 4 / 4 / 3 / 3 / 3 / 3 / 5 / 9 / 6 / 7 / 3 / 0 — SP/SM — Silty SAND with trace of shells and gravel
- Sandy organic SILT with shells
- Silty, gravelly SAND with shells
- OH — Sandy organic SILT with approx. 30% shells
- Silty gravelly SAND with shells

FD-12
JUNE 16 1970
El. -36.0' M.L.W.
- Organic SILT with shells
- OH — Organic SILT with trace of shells

FD-13
JUNE 17 1970
El. -36.8' M.L.W.
- OH — Organic SILT with trace of sand
- 6 / 10 — SM — Gravelly, silty organic SAND with shells
- 8 / 9 / 8 / 3 — SP — Gravelly SAND with trace of silt
- OH — Organic SILT with traces of sand, shells and fibers

FD-14
JUNE 22 1970
El. -35.2' M.L.W.
- OH — Organic SILT with shells
- Organic SILT with shells (plastic)
- Organic SILT with shells
- 3 / 5 / 4 / 9 / 11 / 27 / 24 — SM — Silty SAND with shells "sticky"
- SP — Medium to fine SAND with trace of silt and coarse sand

FD-15
JUNE 22 1970
El. -38.8' M.L.W.
- N.S
- OH — Organic SILT odorous with shells (plastic)

FD-16
JUNE 23 1970
El. -38.7' M.L.W.
- OH — Organic SILT with shells
- Organic SILT odorous, plastic and with shells
- 3/4 / 3 — SM — Silty, medium to fine SAND with trace of gravel and shells
- OH — Alternating lenses of silty fine SAND (SM) and sandy organic SILT (OH) with fibrous material
- Organic SILT very fibrous

FD-17
JULY 1 1970
El. -38.2' M.L.W.
- N.R
- Organic SILT with shells
- OH — Organic SILT odorous

FD-18
JULY 1 1970
El. -36.3' M.L.W.
- OH — Organic SILT with shells
- Organic SILT

FD-19
JULY 7 1970
El. -36.8' M.L.W.
- OH — Organic SILT with shells
- 5 / 10 / 14 / 16 — OL — Sandy SILT organic with lenses of medium to fine sand

FD-20
JULY 7 1970
El. -37.2' M.L.W.
- OH — Organic SILT with shells
- 5 / 5 / 7 / 17 / 16 / 13 / 9 — GM — Silty, sandy GRAVEL
- 16 / 30 / 26 / 14 / 12 — GP/GM — Silty, sandy GRAVEL

FD-21
JULY 8 1970
El. -33.7' M.L.W.
- Organic SILT with vegetation
- OH — Organic SILT
- Organic SILT with shells and pieces of wood

FD-22
JULY 8 1970
El. -36.8' M.L.W.
- OH — Organic SILT with shell fragments
- 8 / 16 / 19 / 14 / 20 — SM — Silty, fine SAND with thin clayey lens

FD-23
JULY 9 1970
El. -31.2' M.L.W.
- OH — Organic SILT with shells and vegetation
- 26 / 37 / 31 / 23 / 26 / 22 — SM — Gravelly SILTY medium to fine SAND
- 23 / 26 / 31 / 33 / 10 / 12 / 18 / 16 / 17 — ML — Fine, sandy SILT
- SM — Silty, fine SAND

FD-24
JULY 9 1970
El. -34.8' M.L.W.
- OH — Organic SILT with shells
- 11 / 9 / 6 / 4 / 3 / 8 / 6 / 10 — SP/SM — Silty, medium to fine SAND
- Silty medium to fine SAND with occ. shell fragments and vegetation
- SM — Silty gravelly medium to fine SAND with thin clayey seams

FD-25
JULY 10 1970
El. -34.9' M.L.W.
- OH — Organic SILT
- 21 / 22 / 24 — SP — Medium to fine sandy SILT (Sand appears to be lenticular)
- Medium to fine SAND with trace of silt
- 16 / 20 / 24 / 28 / 30 — ML — SILT with trace of sand (laminated)

FD-26
JULY 13 1970
El. -38.7' M.L.W.
- OH — Organic SILT
- 4 / 6 / 10 / 13 / 19 / 21 / 11 / 13 / 18 / 16 / 17 — ML — SILT

FD-27
JULY 13 1970
El. -23.8' M.L.W.
- OH — Organic SILT

* Weight of tools

LEGEND FOR GRAPHIC LOGS

FD — Test Boring
Date exploration completed
El. - M.L.W. — Elevation of ground surface during time of exploration.
OL — Group letter symbol according to Unified Soil Classification System.
NS — Not Sampled. Hole advanced by Core-drilling, blasting and or wash boring due to operational difficulty.
35 — Number of blows per foot of penetration using a 350 lb. hammer falling freely about 18-inches on a 1⅜" or 2" I.D. Sample spoon equipped with a beveled and sharpened drive shoe. Fractional foot of penetration indicated as follows: number of blows/tenths of a foot (15/4)
NR — No recovery or unsatisfactory soils samples recovered

NOTES

Normal length of continuous drive of sampling spoon is 5.0 feet. Penetration resistance of sampling spoon increases with length of drive and blow counts, therefore generally increase correspondingly except where distinct changes in material occur within the length of drive. In gravels, sands and gravels and some glacial tills the presence of coarse gravel, cobble or boulder sizes causes the blow count to become erratic, and therefore may not be indicative of the degree of compaction.

While the explorations are representative of subsurface conditions at their respective locations and for their respective vertical reaches local variations characteristic of the overburden and rocks of this region are anticipated and if encountered such variations will not be considered as differing "materially" from represented conditions within the purview of Article 4 of the contract.

FD-1 to FD-5 are drive borings made in November 1953. Area was dredged to -35.0 MLW in June 1954 with allowable overdepth of 2 feet.

SAFETY PAYS

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

SUBMITTED	APPROVAL RECOMMENDED	REVIEWED	APPROVAL RECOMMENDED	CHIEF, TECH. ENG. BRANCH
R.R. R.D.S.	CHIEF, GEOLOGY SECTION	CHIEF, Y & H. BRANCH	PROJECT ENGINEER	CHIEF, ENGINEERING DIVISION

FALL RIVER HARBOR MASS. & R.I.
IMPROVEMENT DREDGING 40-FOOT CHANNELS
DESIGN MEMO-BORING LOGS

APPROVED — DATE AUGUST 1972

TO ACCOMPANY DESIGN MEMORANDUM DATED 21 AUGUST 1972

SCALE AS SHOWN — SPEC. NO. DACW 33 — DRAWING NUMBER F.R. 262

SHEET 10 OF 10

APPENDIX A

FALL RIVER HARBOR PROJECT

ECONOMICS

1972

FALL RIVER HARBOR
APPENDIX A
ECONOMICS

1. General. Fall River Harbor, primarily a receiving port, is a principal transfer point for petroleum products delivered to retail markets in the tributary area. Petroleum is received at this harbor for two electric generating stations located adjacent to the channels. Since delivery of the fuel is direct, there is no need for rehandling. Direct delivery in this manner reduces costs and provides for more economical power in the tributary area. The savings relate directly to power costs since fuel costs are included in determination of allowable power rates, as determined by State regulatory agencies.

2. Within Fall River Harbor there are two 35-foot deep channels which originate in the deep waters of Mount Hope Bay. One, known locally as the "Bay Channel", serves the upper part of the harbor and is located in the municipalities of Somerset and Fall River, Massachusetts. Deep draft commerce to this area consists chiefly of petroleum products. The Tiverton channel services several major waterfront oil terminals in Tiverton, R. I. Until recently, the existing 35-foot channels have been sufficient for harbor commerce. However, because of the rising trend in the size of tankers, the harbor is approaching inadequacy. The larger vessels are subject to tidal delays now, and in many cases in the future will be denied navigation altogether. Improvement of the channels will reduce or eliminate the navigation deficiency, thereby producing more economical transportation of the commerce. The benefits in transportation savings are dependent upon volume of commerce carried and the future vessel sizes. The anticipated increase in future commerce depends largely on projected population rise during the same period.

3. Population. The population of the tributary area served by Fall River Harbor was estimated to be 1,130,000 in 1970. According to the Bureau of the Census, the national population is growing at an average annual increase of 1.3% and is expected to do so through 2024, the final year of the project life. All indications are that the population of the tributary area is growing at a comparable rate.

By 1974, the first year of project life, the populace of the subject area will have increased to 1,189,000. An increase of 65% in inhabitants of the area should be realized by 2024. This would yield a population of 1,962,000.

4. Statistics provided by the American Petroleum Institute show that the national per capita demand for petroleum products in 1965 was 21.7 barrels. A projected rise to 26.7 barrels is expected by the turn of the century and by 2024, a national per capita demand of 32.1 barrels will be reached.

5. Northeastern United States is the greatest petroleum using sector of the country. Per capita rates for New England run 38 percent above the National average. In 1960, the per capita rate for this area was 25.6 barrels of petroleum and by 1968 it had increased to 34.6 barrels, an increase of 9 barrels in 8 years or an average annual per capita increase of 1.1 barrels per year. The National per capita rate will begin leveling off as nuclear energy replaces petroleum now being used in many of the power production plants. However, the percentage of per capita petroleum use in New England compared to that of the rest of the Nation is expected to continue at 38 percent. Therefore, by the year 1999, the local per capita will be 36.8 barrels and by 2024, the final year of project life, it will have risen to 44.3 barrels annually.

6. Commerce. Commerce in Fall River Harbor has consistently shown an increase throughout the years. In 1955, the total overall commerce totaled 2,013,161 tons but by 1970, trade had risen 115 percent to 4,333,530 tons. This amounts to an average annual increase of 7.2 percent in tons received, which is due in part to the rise in receipts of petroleum products. Petroleum products, the major commodities received at Fall River in 1970, amounted to 3,851,407 tons, or 89 percent of the total commerce. In the past, bituminous coal shipments were important to this area, accounting for 42 percent of the total commerce in 1964, but by 1970 no coal was being received in Fall River Harbor. Of the total 1970 petroleum receipts of 3,851,407 tons, 1,859,833 tons were foreign imports and the 1,991,574 tons were involved coastwise traffic. The following Table A-1 provides a statement of traffic for the past 15 year period.

TABLE A-1

TOTAL COMMERCE

Year	Short tons	Passengers
1955	2,013,161	18,136
1956	2,201,889	34
1957	2,101,120	
1958	2,101,916	1,212
1959	2,174,230	
1960 (1)	2,942,012	
1961	2,179,633	
1962	2,599,329	
1963	2,737,650	
1964	3,161,590	
1965	3,661,963	62
1966	4,040,441	21,180
1967	3,850,063	1,112
1968	3,541,631	17,030
1969	4,261,327	600
1970	4,333,530	778

(1) 1960 commerce shows an abnormal increase over the previous year due to 770,000 tons of granite designated for breakwater construction at Newport, Rhode Island.

7. Future Commerce. Commerce in this harbor is expected to increase substantially in the future. The greatest rise should be in the petroleum products which are received at the oil terminals and distributed to the retail market.

8. In 1970, commerce to the Montaup Electric Company included only oil. The plant located entirely above the bridge has a rated capacity of 330,000 kilowatts and has recently added a small jet turbine which generates 20,000 kw. Oil will be used exclusively in the future with existing coal units being converted to oil. Table A-2 shows the computation for the annual average fuel consumption for the Montaup Electric Company.

9. The Montaup Electric Company has property below the bridge sufficient for installation of a 1,000,000 to 1,500,000 kw plant. A unit of 20,000 kw capacity, similar to the one recently added, will probably become a reality within the next few years. This unit has been included in the future petroleum demands of the company. An additional 600,000 kw unit has been projected to be built on the property below the bridge about 1999.

TABLE A-2

Estimates of Fuel Consumption Over Project Life
(Power Companies)

Load Factor, Power Area 2 - (FPC 1980)	57%
Average annual heat rate (FPC)	9400 BTU/kw/hr.
Average annual operating time in hours	
365 x 24 x .57 =	4993 hrs.
BTU requirement/kw/yr.	
4993 x 9400 =	46,934,000
Average annual requirements - Oil	
Oil - 19,250 BTU/lb. (heat content) API	
$\frac{46,934,000}{19,250}$ = 2438 #/kw/yr. =	1.2185 tons/kw/yr.

Montaup

1970 - 350,000kw x 1.2185 = 426,475 tons of oil
1974 - 370,000kw x 1.2185 = 450,845 tons of oil
1999 - 970,000kw x 1.2185 = 1,181,945 tons of oil
2024 - 970,000kw x 1.2185 = 1,181,945 tons of oil

New England Power

1970 - 1,060,000kw x 1.2185 = 1,291,610 tons of oil
1974 - 1,510,000kw x 1.2185 = 1,839,935 tons of oil
1999 - 1,510,000kw x 1.2185 = 1,839,935 tons of oil
2024 - 1,510,000kw x 1.2185 = 1,839,935 tons of oil

Total Power Companies

1970 - 1,410,000kw = 1,718,085
1974 - 1,880,000kw = 2,290,780
1999 - 2,480,000kw = 3,021,880
2024 - 2,480,000kw - 3,021,880

10. Future commerce will be augmented by the continuous growth of the New England Power Company. Since July 1963, when the company began operating its first 250,000 kw unit, it has added another unit of equal size and also a 560,000 kw unit. New England Power Company recently filed application for a permit to operate a 450,000 kw unit, and if approved will begin operation by 1974, the first year of project life. New England Power Company using oil exclusively in the future as coal reserves on hand are depleted, expects to bring in 1,698,675 tons of oil during 1971. If the 450,000 kw unit is approved, an additional 550,000 tons of oil will be required for operation. New England Power Company's future demands are expressed in Table A-2.

11. Tables A-3 and A-4 show the estimated future receipts of petroleum products to existing terminals, exclusive of power plant receipts. These receipts are based on petroleum per capita demand and population projections discussed in previous paragraphs. Table A-5 summarized the estimated future receipts of deep draft commerce in Fall River. The year 1974 was used as the first year of the project life.

12. The Air Force terminal at Tiverton, Rhode Island is now only receiving jet fuel. (Not considered in Benefit Analysis)

13. Vessel Traffic. As stated, petroleum products comprise 89 percent of the 1970 commerce into Fall River. These commodities are carried in tankers ranging from T-2's (16,500) to 32,000 dwt. During 1970, 157 tankers drawing more than 27 feet entered the harbor. The size of vessels in the world tanker fleet has been rapidly increasing in the past few years. In 1964, only 25% of the world tankers drew 35' or greater, but by 1968 this figure had jumped to 35%. Smaller tankers, those with a 30' draft or less, comprised almost 52% of the tanker fleet in 1964, but by 1968 these vessels amounted to only 45% of the total fleet.

14. The deepening of the harbor will allow larger tankers to navigate the area. Since the average tanker size is increasing rapidly, it will be most important that these vessels can be accommodated in the future. Much of the commerce destined for Fall River originates in Gulf, West Indian, or South American ports resulting in high transportation costs, particularly with smaller size tankers. The costs are reduced considerably with the use of the larger vessels.

TABLE A-3

ESTIMATE OF FUTURE RECEIPTS OF PETROLEUM, EXCLUSIVE OF POWER PLANTS

Fall River (Bay Channel)

Year	Receipts (Short Tons)	Population Increase Factor	Demand Increase Factor		Petroleum Receipts
1970	1,666,700				1,666,700
1974	1,666,700 x	(1.3% x 4 yrs,)	$\frac{35}{35}$	=	1,753,400
1978	1,666,700 x	(1.3% x 8 yrs.)	$\frac{36}{35}$	=	1,892,592
1999	1,666,700 x	(1.3% x 29 yrs.)	$\frac{44}{35}$	=	2,885,200
2024	1,666,700 x	(1.3% x 54 yrs.)	$\frac{44}{35}$	=	3,566,200
2028	1,666,700 x	(1.3% x 58 yrs.)	$\frac{44}{35}$	=	3,675,100

TABLE A-4

ESTIMATE OF FUTURE RECEIPTS OF PETROLEUM, EXCLUSIVE OF POWER PLANTS

Tiverton

Year	Receipts (Short Tons)	Population Increase Factor	Demand Increase Factor		Petroleum Receipts
1970	714,300				714,300
1974	714,300	(1.3% x 4 yrs.)	$\frac{35}{35}$	=	751,400
1999	714,300	(1.3% x 29 yrs.)	$\frac{44}{35}$	=	1,236,500
2024	714,300	(1.3% x 54 yrs.)	$\frac{44}{35}$	=	1,528,400

TABLE A-5

ESTIMATED FUTURE RECEIPTS (PETROLEUM)

Fall River

Year	Power Companies	Petroleum Receipts Excluding Power Co.	Total Fall River
1970	1,718,085	1,666,700	3,384,785
1974	2,290,780	1,753,400	4,044,180
1978	2,290,780	1,892,592	4,183,372
1999	3,021,880	2,885,200	5,907,080
2024	3,021,880	3,566,200	6,588,080
2028	3,021,880	3,675,100	6,696,980

Tiverton

Year	Power Companies	Petroleum Receipts Excluding Power Co.	Total Fall River
1970		714,300	714,300
1974		751,400	751,400
1999		1,236,500	1,236,500
2024		1,528,400	1,528,400

COMBINED TOTAL - FALL RIVER/TIVERTON

Year	Power Companies	Petroleum Receipts Excluding Power Co.	Total Fall River/Tiverton
1970	1,718,085	2,381,000	4,099,085
1974	2,290,780	2,504,800	4,795,580
1999	3,021,880	4,121,700	7,143,580
2024	3,021,880	5,094,600	8,116,480

15. The benefits have been evaluated separately for each of the two channels. This method was deemed necessary since each channel functions independently and has different navigation problems. At present, petroleum products can be received in 32,000 dwt vessels in the Tiverton Channel. These vessels draw 34 feet and are brought in at high tide in this existing 35-foot channel. Therefore, if a vessel arrives at a time other than high tide, there is a tidal delay. This time amounts to additional costs which are added to the transportation cost of the delivered product. The additional expenses are reflected in the hourly operating costs of the vessel. Benefits for the elimination or reduction of tidal delays are based on the average waiting time for the vessels. Additional benefits are resultant from the ability to use deeper draft ships at lower costs per ton.

16. The existing bay channel has a controlling depth of 35 feet and normally could accommodate 32,000 dwt tankers. However, due to the Brightman Street Bridge spanning the channel, safe navigation precludes the passage of tankers larger than Jumbo T-2 (20,000 dwt.). In view of this aspect of navigation, benefits have been evaluated for the savings to be realized by using 32,000 dwt tankers in lieu of 20,000 dwt and have been attributed to bridge alteration. Benefits realized from the potential deepening of the existing 35-foot channel to 40 feet are based on the use of tankers larger than 32,000 dwt, and exclude benefits resulting from the change from Jumbo T-2 tankers to 32,000 dwt tankers.

17. Docking and undocking procedures for all sections of the harbor entail the use of 2 or 3 towboats. Improvement, by enabling the larger ships to navigate the waterway, would allow for delivering annual volumes of products on fewer trips, thus reducing the annual cost of towboat hire. The amount of reduction is taken as an annual benefit, attributable to navigation improvement.

TABLE A-8

TRENDS IN VESSEL TRAFFIC
FALL RIVER HARBOR

Draft Ft.	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
36										1		1
35	2		1	1						1	3	2
34			1	4	6	6	1			2	30	3
33	3	9	1	1	18	32	3		3	8	17	12
32	28	22	5	10	27	31	31	22	31	34	54	60
31	40	49	48	43	40	39	35	53	48	59	62	66
30	22	12	35	34	41	34	13	9	1	5	6	5
29	10	1	3	6	5	9	8	3		2	4	6
28	4	2	1	12	3	5	4	1	1			2
27	1			8	4	2	1	3	1	4	4	3

TABLE A-9

TRANSPORTATION COSTS FOR PRESENT 35-FT. AND AUTHORIZED 40-FT. DEPTHS (PETROLEUM)

Tanker Size (dwt)	Cost/Ton 35'	Cost/Ton 40'	Tonnage (1000)	Total ($1000)
		Commerce Above Bridge - Domestic		
		1974		
21,000	3.72		1403	5219
32,000	3.26		1403	4574
37,000		3.10	1403	4349
		1978		
21,000	3.72		1514	5632
32,000	3.26		1514	4936
37,000		3.10	1514	4693
		2024		
21,000	3.72		2853	10613
32,000	3.26		2853	9301
47,000		2.68	2853	7646
		Commerce Above Bridge - Foreign (Exclusive of Power)		
		1974		
21,000	2.10		349	733
26,000	1.93		349	674
37,000		1.63	349	569
		1978		
21,000	2.10		379	796
26,000	1.93		379	731
37,000		1.63	379	618
		2024		
21,000	2.10		713	1498
26,000	1.93		713	1376
37,000		1.67	356	595
47,000		1.43	356	509

TABLE A-9 Continued

TRANSPORTATION COSTS FOR PRESENT 35-FT. AND AUTHORIZED 40-FT. DEPTHS (PETROLEUM)

Tanker Size (dwt)	Cost/Ton 35'	Cost/Ton 40'	Tonnage (1000)	Total ($1000)
		Commerce Above Bridge - Foreign-Power		
		1974		
21,000	2.10		451	947
26,000	1.93		451	870
37,000		1.63	451	735
		1978		
21,000	2.10		451	947
26,000	1.93		451	870
37,000		1.63	451	735
		2024		
21,000	2.10		451	947
26,000	1.93		451	870
37,000		1.67	225	376
47,000		1.43	226	323

TABLE A-10

TRANSPORTATION COSTS FOR PRESENT 35-FT. AND AUTHORIZED 40-FT. DEPTHS (PETROLEUM)

Tanker Size (dwt)	Cost/Ton 35'	Cost/Ton 40'	Tonnage (1000)	Total ($1000)
	Commerce Below Bridge Bay Channel - Foreign (Exclusive of New Plant in 1999)			
		1974		
26,000	1.93		1840	3551
37,000		1.67	1840	3073
		2024		
26,000	1.93		1840	3551
37,000		1.67	920	1536
47,000		1.47	920	1352
	Commerce Below Bridge Bay Channel - Foreign (Installation of New Plant in 1999)			
		1999		
26,000	1.93		732	1413
37,000		1.67	549	917
47,000		1.47	183	269
		2024		
26,000	1.93		732	1413
37,000		1.67	366	611
47,000		1.47	366	538
	Tiverton Channel (Domestic)			
		1974		
26,000	3.64		750	2730
37,000		3.10	750	2325
		2024		
26,000	3.64		1528	5562
37,000		3.10	764	2368
47,000		3.10	764	2368

TABLE A-11

TRANSPORTATION COST SAVINGS,
CHANNELS 35-FT. VS 40-FT. DEPTHS

Channel Depth	Trans. Costs ($1000)	Savings vs 35' Channel ($1000)	Savings Increase 1974-2024	Average Annual Equivalent (3.250-.3824)
Bay Channel Above Bridge - Domestic				
		1978		
35' w/bridge	5632			
35' w/o bridge	4936	696		
40'	4693	300		
		2024		
35' w/bridge	10613			
35' w/o bridge	9301	1312-696	616	
40'	7646	1655-300	1355	
Bay Channel Above Bridge - Foreign - Exclusive of Power				
		1978		
35' w/bridge	796			
35' w/o bridge	731	65		
40'	618	113		
		2024		
35' w/bridge	1498			
35' w/o bridge	1376	122-65	57	
40'	1104	272-113	159	
Bay Channel Above Bridge - Foreign Power				
		1978		
35' w/bridge	947			
35' w/o bridge	870	77		
40'	735	135		
		2024		
35' w/bridge	947			
35' w/o bridge	870	77		0
40'	699	171-135	36	14

TABLE A-11 Continued

TRANSPORTATION COST SAVINGS,
CHANNELS 35-FT. VS 40-FT. DEPTHS

Channel Depth	Trans. Costs ($1000)	Savings vs 35' Channel ($1000)	Savings Increase 1974-2024	Average Annual Equivalent (3,250-.3824)
		Bay Channel Below Bridge - Foreign Exclusive of Project Power Plant		
		1974		
35'	3551			
40'	3073	478		
		2024		
35'	3551			
40'	2888	663-478	185	71
		Bay Channel Below Bridge - Foreign Power Plant - 1999		
		1999		
35'	1413			
40'	1186	227 x 0.2579		59
		2024		
35'	1413			
40'	1149	264-227=37x0.1408		5
		Tiverton Channel - Domestic		
		1974		
35'	2730			
40'	2325	405		
		2024		
35'	5562			
40'	4736	826 - 405 = 421		161

18. Transportation costs are based on hourly operating costs of vessels for the round trip time from ports of origin to Fall River Harbor. A 24-hour allowance is made for unloading. The following table shows the operating costs of specific vessels as derived from published data.

TABLE A-12

CHARACTERISTICS OF OCEANGOING TANKERS

Dead Weight (Long Tons)	Length (ft.)	Beam (ft.)	Design Draft	Speed (knots)	Operation Costs (Dollar/hr) U.S. Flag At Sea	U.S. Flag In Port	Foreign Flag At Sea	Foreign Flag In Port
16,500 T-2	523	68	30'6"	14.5	200	182	115	96
21,000 jumbo T-2	572	75	31'6"	14.5	251	233	143	124
25,000 jumbo T-2	585	80	32'0"	14.5	266	247	152	132
26,000	605	78	34'0"	16.5	338	309	181	153
37,000	660	90	35'6"	16.5	405	360	226	181
47,000	736	99	38'0"	16.5	435	389	243	197

19. The data in Table No. A-12 were used in estimating per ton delivery of petroleum products from Gulf and South American ports. Typical computation of delivery costs follow:

Point of Origin: So. America and Gulf Ports

21,000 dwt tanker

Basic Data:

Distance 2100 nautical miles
Cruising speed 14.5 knots
Hours for fully loaded or unloaded at each port - 24 hrs.

Hourly Operating Costs:

At Sea $143
In Port $124

Round Trip at Sea:

14.5 knots x 24 hrs. = 348 nautical miles/day

$\frac{2100 \text{ miles}}{348}$ = 6.03 days. Round trip = 12.06 days

Payload = 21,000 x 0.96 x 1.12 = 22,600 short tons

Costs at Sea:

$143 x 12.06 x 24 = $41,390
48 hrs. in port x $124 = $5,952
Total $47,342 - Say $47,300

Tidal Delay 31.5' draft clearance 4.0'

Total depth needed - 31.5 + 4.0 = 35.5'

Channel depth available - 35.0'
Tide height required - 0.5'
Delay time - 2.7 hours: transit time - 1 hour

$\frac{3.7}{12.4} \times \frac{3.7}{2}$ = 0.55 Say 1 hour

Tidal delay 1 hour x $143 = 143 - negligible

Cost/Ton

Trip-cost - $47,300

Cost/Ton = $\frac{\$47,300}{22,600}$ = $2.10

Typical Derivation of Petroleum Delivery Costs (U.S. Registry)

Tanker Class 47,000 dwt — 40 foot channel

Av. Dist. (Gulf Ports) — 2100 nautical miles

Cruising speed 16.5 knots — draft 38'

16.5 x 24 = 396 nautical miles/day

$\frac{2100}{396}$ = 5.30 days

5.30 x 2 = 10.6 days (rd. trip @ sea)

Pay load = 47,000 dwt x 0.96 x 1.12 = 50,535 short tons

Hourly operating costs @ sea $435.00; in port $389.00

$435 x 10.6 x 24 = $111,000 (rd trip @ sea)

60 hrs. in port x $389 = 23,300

Sub-Total = 134,300

Tidal delay 3.0 hours x 435 = $1,300

Trip Cost = $135,600

$\frac{135,600}{50,535}$ = $2.68/short tons

20. In computation of the benefits, allowances were made for the necessary time element required for the completion of the project. It is estimated that the first full year of improvement would be in 1974. Therefore, benefits were evaluated for that year and for 2024, the final date of the 50-year project life.

21. Tables A-9 and A-10 show transportation costs for the present 35' and authorized 40' channel depths for the various types of tankers. Table A-11 shows transportation cost savings for the 40' channel depth. Table A-12 was used for development of delivery costs benefits for petroleum commerce. Table A-13 summarizes for petroleum commerce benefits for the 40' channels. The anticipated petroleum receipts have been divided into two categories - domestic and foreign. This procedure is necessary as transportation costs for domestic tankers are higher than for similar foreign tankers. Currently, the oil terminals above the bridge receive about 80% domestic and 20% foreign products. Power plant fuel is all of foreign origin. It was determined that the larger vessels would not come into universal use immediately after improvement but will replace smaller ones at an even rate over the project life. The commerce will be carried in 37,000 dwt tankers in comparison to the maximum 32,000 dwt tankers which can be used in the present 35' channel. Larger vessels used by the 50th year of the project life will be 47,000 dwt. Benefits for the larger vessels are based on a combination of 37,000 and 47,000 dwt tankers in that year. Equal use of each type was assumed. Tables A-9, A-10, and A-11 show transportation costs and savings to be attained.

TABLE A-13

BENEFIT SUMMARY - PETROLEUM COMMERCE
(50-Year Life - 40' Channel)

BAY CHANNEL ABOVE BRIDGE - DOMESTIC

	(1000)	Benefit	(1000)
Benefits 1978 (continuous 46 yrs.)	128		
Incremental Benefits (1978-2024 adjusted to reflect 50 yr project life)	349		
Total Domestic Benefit Above Bridge		477	

BAY CHANNEL ABOVE BRIDGE - FOREIGN

Foreign Power and Non Power:			
Benefits 1978	211		
Benefit 1978-2024	100		
Total Foreign		311	
Total Bay Benefits Above Bridge			788

BAY CHANNEL BELOW BRIDGE - TIVERTON

Domestic	(1000)	Benefit
Benefit 1974 (continuous 50 yrs)	405	
Incremental Benefit 1974-2024	161	
Total Domestic Benefit	566	
50% allocated to pt of origin	283	
NET BENEFIT		283
Foreign - Total Below Bridge		613
Total Petroleum Benefit Below Bridge		896
Total Petroleum Benefit - Above & Below Bridge		1,684

22. By the year 2024, petroleum receipts in the Bay Channel are expected to reach 6,588,000 tons. If this tonnage was carried in 32,000 dwt vessels with a cargo capacity of 34,300 short tons, 192 vessels trips would be required. After improvement, the same tonnage if carried in a combination of 37,000 and 47,000 dwt vessels, having cargo capacities of 39,775 short tons and 50,525 short tons, respectively, could be delivered in 149 trips, assuming that 50% of the total was carried in each class. Thus a total of 43 vessel trips would be eliminated with consequent reduction in the annual towboat hire. Average towboat costs are $1,800 per vessel trip, which includes docking and undocking. Total savings would thus be $1,800 x 44 or $77,400. As this savings would be realized in 2024, reduction to its annual average equivalent becomes $29,598, an average annual benefit.

23. Similar benefits were computed for the Tiverton Channel. The 2024 commerce of 1,528,000 tons could be delivered in 45 trips of 32,000 dwt tankers. The combination of 37,000 and 47,000 dwt tankers could deliver the same commerce in 38 trips, thus saving 7 trips. With the average towboat costs of $1,800 per vessel trip, a savings of $12,600 would be realized. Reduction to its average annual equivalent would be $4,818 over the 50-year project life.

FALL RIVER - ANNUAL BENEFITS

1974 - 2024

Benefits Above Bridge (Bay Channel)

Domestic	$477,000
Foreign	311,000
Total Petroleum	$788,000
Towboat Saving	30,000
Total Benefits Above Bridge	$818,000

The benefits above the bridge are based on the average annual equivalent for the project year plus four. The benefits above the bridge are not obtainable until the channel below the bridge is dredged. Therefore, it seems reasonable to prorate the above bridge bay channel benefits on the basis of the channel lengths concerned.

Total length of bay channel	38,000 ft.
Above bridge length	8,500 ft.
Below bridge length	29,500 ft.

Benefits Above Bridge Prorated		
Above Bridge	$180,000	
Below Bridge	638,000	
Total Benefits to Terminals Above Bridge	$818,000	
Benefits Above Bridge (Bay Channel)		$180,000
Benefits Below Bridge (Bay Channel)		
Foreign	$613,000	
Prorata share	638,000	
Total Benefits Below Bridge (Bay Channel)		$1,251,000
Benefits Tiverton Channel		
Domestic	$283,000	
Towboat Savings	5,000	
Total Benefits Tiverton Channel		$288,000
Benefits Bridge Alteration		
Domestic	$910,000	
Foreign	204,000	
Total Benefits Bridge Alteration		$1,114,000
Total Benefits Fall River Project		$2,833,000

APPENDIX B

FALL RIVER HARBOR PROJECT

REPORT ON

ENVIRONMENTAL SAMPLING AND TESTING

1971

EXPLORATIONS

Sampling within the area to be dredged consisted of 131 piston cores, 16 of which were for the express purpose of taking environmental samples. Additional sampling for comparison included 10 pressed piston tubes, 11 grabs in Taunton River upstream from the project area, and four piston cores in the planned disposal ground off Newport, Rhode Island. All samples were taken during the summer and autumn of 1970 and early 1971.

DISCUSSION OF TEST DATA

Samples were analyzed for biological, chemical, and physical properties. Of the roughly 4,000,000 cubic yards of material to be dredged, about 3.2 million are classified as organic silt and the remaining 0.8 million cubic yards are granular materials and inorganic silts.

Volatile solids in Fall River Harbor ranged from 3.36% to 10.54% and average 6.4%. Volatile solids in the Newport disposal area ranged from 0.75% to 2.18% and average 1.26%.

Five day BOD in Fall River Harbor ranged between 1.73 and 2.57 mgO_2 per L/0.5 gm and averaged 2.20 mg, while in the Newport spoil area the range was 1.98 to 2.61 with an average of 2.19 mg. All fish survived bioassay.

Hexane solubles in Fall River Harbor ranged 0.01 to 0.23% with an average of 0.07%. In the spoil area the range was 0.06 to 0.09% and average of 0.07%.

Mercury in Fall River Harbor ranged from .0000137 to .000256% and averaged .0000362%. Samples upstream, in the Taunton River ranged between .000015 and .000747% and averaged .000336%. It was noted that there was an abrupt drop in mercury content crossing into the Fall River Harbor project limit. Furthermore, grab samples showed higher contents than core samples, indicating that the mercury is concentrated at the surface. It is hypothesized that similar concentrations existed in the Fall River Harbor project area and that most of the mercury was removed by prior dredging. Mercury in the Newport disposal ground ranged between .0000019% and .0000062% and averaged .0000031%.

The zinc content of Fall River Harbor sediment ranged between .00565% and .00826% with an average of .00676%. In the Newport disposal ground the range was from .00238% to .00637% and averaged .00495%.

There were no detectable pesticides or polychlorinated biphenyls at a sensitivity of one ppb.

PISTON CORE BOTTOM SAMPLES

Samples were obtained inside a 1-7/8" I.D. 2" O.D. transparent plastic liner tube contained inside a 5-1/2 foot standard black iron pipe fitted with a beveled and sharpened drive shoe. Penetration was by free fall of 5 feet, except where noted otherwise. The assembly was ballasted with 360# of lead weight, except where noted otherwise. Free fall distance was controlled by a release mechanism which was triggered by a suspended pilot weight trip which struck the bottom at a fixed distance below the cutter head. The sample was induced in the tube by means of a gasketed piston suspended at bottom level by a wire rope and the core barrel fell around the fixed piston. A spring leaf type core catcher between the core tube and the barrel retained the sample.

Soundings were by leadline and were reduced by tide curve. Locations were by sextant, plotted on computer-drawn sextant charts automatically computed from survey coordinated sights. Samples were taken from Corps of Engineers tugboat Manamet. Description of materials are those of the Inspector, Richard Semonian, unless accompanied by asterisk denoting laboratory analysis and classification.

CORE NO. K-	BOT. EL. MLW	MATERIALS	DEPTH RANGE IN FEET
1	37.2	Sandy organic SILT Gravelly, organic silty SAND	0.0-3.2 3.2-4.2
2	31.9	Gray Silty SAND Gray Sandy GRAVEL	0.0-1.1 1.1-1.8
3*	40.5	Dk. brown, organic SILT w/organic odor & shell fragments	0.0-5.0
4	39.0	Dk. brown organic SILT w/odor & shells	0.0-5.0
5	38.3	Dk. brown, organic SILT w/odor & shells	0.0-5.0
6	38.7	Dk. brown organic SILT Dk. brown sandy, gravelly SILT	0.0-0.4 0.4-2.1
7	36.6	Dk. brown organic SILT Lt. brown fine sandy SILT (strat.)	0.0-2.8 2.8-3.3
8	37.6	Dk. brown, organic SILT w/odor & shell fragments	0.0-5.0
9	35.5	Black, loose organic SILT	0.0-5.0
10	38.5	Dk. brown, organic SILT w/odor, shells & one starfish	0.0-5.0
11	38.2	Dk. brown, loose organic SILT Brown, gravelly sandy SILT	0.0-3.5 3.5-4.8
12*	38.2	Dk. brown, loose organic SILT w/odor & shell fragments	0.0-4.8
13	37.4	Dk. brown sandy organic SILT Dk. gray organic silty SAND w/odor	0.0-1.1 1.1-4.9
14	47.7	Dk. gray silty SAND Dk. gray sandy gravelly SILT	0.0-1.1 1.1-4.2
15	38.6	Gray silty sandy GRAVEL	0.0-1.1
16	38.5	Black sandy organic SILT Dk. gray, silty sandy GRAVEL	0.0-0.9 0.9-1.3

CORE NO. K-	BOT. EL. MLW	MATERIALS	DEPTH RANGE IN FEET
17	38.0	Black, loose organic SILT Black gravelly silty SAND	0.0-4.0 4.0-5.0
18	41.7	Dk. brown organic SILT w/odor & shells	0.0-5.0
19*	31.6	Dk. brown, very loose organic SILT	0.0-3.4
20	38.5	Dk. brown organic SILT w/odor & shells	0.0-5.0
21	38.5	Dk. brown, organic SILT w/odor & shells	0.0-5.0
22	32.6	Black organic SILT Gray silty gravelly SAND	0.0-4.1 4.1-5.0
23	38.4	Med. - fine SAND Trace of GRAVEL	0.0-2.0
24	38.1	Brown, med.-fine SAND	0.0-2.5
25	30.6	Bl. organic SILT w/0.1' layer of SAND	0.0-4.2
26	36.4	Lost Sample	
27*	34.2	Organic SILT	0.0-4.6
28	37.5	Silty fine SAND	0.0-2.0
29	37.5	Gravelly sandy SILT	0.0-0.7
30	31.4	Organic SILT	0.0-4.8
31	35.0	Organic SILT	0.0-4.8
32	38.3	Organic SILT	0.0-5.0
33	37.4	Organic SILT Sandy GRAVEL	0.0-2.0 2.0-3.8
34	37.3	Med-fine SAND Gravelly SAND	0.0-0.6 0.6-1.0
35	37.3	Organic SILT Trace of GRAVEL	0.0-5.0
36	38.0	Gravelly SAND	0.0-1.2

CORE NO. K-	BOT. EL. MLW	MATERIALS	DEPTH RANGE IN FEET
38	37.8	Sandy GRAVEL	0.0-0.6
39	39.4	Organic SILT	0.0-5.0
40	37.8	Gravelly sandy organic SILT Silty sandy GRAVEL	0.0-2.1 2.1-3.7
41	37.5	Organic SILT	0.0-5.0
42*	39.2	Organic SILT	0.0-5.0
43	36.8	Organic SILT	0.0-5.0
44	38.5	Organic SILT	0.0-5.0
45	36.6	Organic SILT Organic silty SAND	0.0-3.6 3.6-5.0
46	26.7	Points obscured - location not valid	0.0-5.0
47	35.2	Organic SILT Med-fine SAND	0.0-1.0 1.0-4.4
48	36.0	SAND w/shells	0.0-3.3
49	37.0	Organic SILT	0.0-4.1
50	36.3	Organic SILT	0.0-5.0
51	35.2	Organic SILT	0.0-4.7
52*	39.2	Organic SILT	0.0-5.0
53	34.9	Organic SILT	0.0-5.0
54		Organic SILT	0.0-5.0
55		Organic SILT	0.0-5.0
56*	37.7	Organic SILT	0.0-5.0
57	38.4	Organic SILT	0.0-5.0
58	38.1	Organic SILT	0.0-5.0
59	39.9	Organic SILT	0.0-5.0
60*	38.2	Organic SILT	0.0-5.0
61*	39.2	Organic SILT	0.0-5.0

CORE NO. K-	BOT. EL. MLW	MATERIALS	DEPTH RANGE IN FEET
62	39.0	Organic SILT	0.0-5.0
63	38.5	Organic SILT	0.0-4.7
64	39.1	Organic SILT	0.0-5.0
65*	36.6	Organic SILT	0.0-3.2
66	36.6	Organic SILT	0.0-3.9
67	39.9	Organic SILT	0.0-3.4
68*	37.3	Organic SILT	0.0-3.2
69	37.6	Brown SAND	0.0-3.8
70	42.6	Lost Sample - Sounding too deep to warrant 2nd attempt	
71	40.2	Organic SILT	0.0-5.0
72	39.4	Organic SILT	0.0-5.0
73*	38.3	Organic SILT	0.0-5.0
74	36.5	Med-fine SAND	0.0-3.8
75	38.7	SAND w/pea gravel	0.0-2.2
76	37.2	Organic silty SAND Organic SILT & peat	0.0-1.5 1.5-3.0
77	39.2	Gravelly sandy SILT	0.0-1.7
78	40.2	Organic silty SAND Trace of pea gravel	0.0-1.8
79	37.6	Organic SILT	0.0-3.1
80	36.5	Organic SILT	0.0-3.9
81		Organic SILT Organic silty SAND	0.0-2.3 2.3-4.4
82	36.0	Organic SILT Gravelly SAND	0.0-1.8 1.8-4.3
83*	38.3	Organic SILT	0.0-5.0
84	45.7	Organic SILT	0.0-5.0

CORE NO. K-	BOT. EL. MLW	MATERIALS	DEPTH RANGE IN FEET
85	38.9	Organic SILT	0.0-5.0
86	32.4	Organic SILT Stratified SILT & CLAY	0.0-4.2 4.2-5.0
87	36.1	SAND Organic SILT	0.0-3.2 3.2-4.9
88	37.3	Organic SILT	0.0-5.0
89*	36.1	Organic SILT	0.0-5.0
90	37.1	Organic SILT Sandy Organic SILT SAND	0.0-2.7 2.7-3.5 3.5-4.1
91	38.1	Sandy Organic SILT Organic Silty SAND	0.0-3.2 3.2-5.0
92	35.9	Organic SILT	0.0-5.0
93*	35.9	Organic SILT	0.0-5.0
94	35.5	Organic SILT	0.0-5.0
95	35.1	Organic SILT	0.0-5.0
96	34.8	Organic SILT	0.0-5.0
97	36.6	Sandy organic SILT	0.0-4.2
98	36.1	Organic SILT Sandy organic SILT	0.0-3.7 3.7-5.0
99	37.0	Sandy organic SILT	0.0-3.9
100	37.2	SAND	0.0-1.8
101*	36.2	Organic SILT	0.0-2.0
102	37.2	Organic SILT Fine SAND, SILT & CLAY (Stratified)	0.0-3.1 3.1-4.6
103	36.7	Organic SILT (trace of sand in bottom of spoon)	0.0-5.0
104	37.2	Organic SILT Clayey SILT (Stratified)	0.0-3.4 3.4-5.0
105*	34.5	Organic SILT	0.0-3.6

CORE NO. K-	BOT. EL. MLW	MATERIALS	DEPTH RANGE IN FEET
106	27.4	Organic SILT	0.0-5.0
107	36.6	SAND	0.0-1.9
108	37.0	Organic SILT	0.0-5.0
109	36.6	SAND w/shells	0.0-3.2
110	37.2	SAND w/trace of GRAVEL	0.0-3.0
111	38.1	SAND	0.0-3.4
112	38.0	SAND	0.0-3.0
113	38.0	SAND	0.0-2.9
114	36.8	Sandy organic SILT SAND w/shells	0.0-3.1 3.1-5.0
115	36.1	SAND	0.0-2.7

FALL RIVER HARBOR, MASS. - R. I.

TEST RESULTS

Explor. No.	Depth Range Ft.	Elev. Below MLW	Classification	Wet Unit PCF	Wet Unit Wgt gm/cc	Dry Unit pcf	Dry Unit Wgt gm/cc	Appar. Specific Gravity	ph	Volatile Solids %	Radio-activity mr/hr	C %	H %	N %	C/N	Hexane Soluble %
KE-1	0.0-5.0	40.3	Organic Silt w/shells													0.04
KE-2	0.0-5.0	40.5	Organic Silt w/shells													0.02
KE-3	0.0-5.0	38.1	Organic Silt w/shells	81.6	1.31	47.6	0.76	2.596	7.0	3.36	0.04	1.98	0.55	0.30	6.6	0.03
KE-4	0.0-5.0	39.1	Organic Silt w/shells	96.4	1.55	53.1	0.85		6.2	5.68	0.06	2.40	0.38	0.42	5.7	0.01
KE-5	0.0-5.0	39.7	Organic Silt w/shells													0.02
KE-6	0.0-5.0	38.7	Organic Silt w/shells													0.02
KE-7	0.0-5.0	37.0	Organic Silt w/shells	84.1	1.35	52.1	0.83		7.4	4.12	0.07	1.51	0.29	0.26	5.8	0.01
KE-8	0.0-5.0	39.5	Org.Clayey Silt w/shells													0.03
KE-9	0.0-5.0	38.5	Org.Clayey Silt w/shells													0.02
KE-10	0.0-5.0	38.3	Org.Clayey Silt w/shells	75.1	1.20	42.0	0.67		7.7	6.01	0.06	2.27	0.34	0.31	7.3	0.03
KE-11	0.0-5.0	38.4	Org.Clayey Silt w/shells													0.02
KE-12	0.0-5.0	38.2	Org.Clayey Silt w/shells													0.23
KE-13	0.0-5.0	37.7	Org.Clayey Silt w/shells													0.03
KE-14	0.0-5.0	39.0	Org.Clayey Silt w/shells													0.01
KE-15	0.0-5.0	37.7	Org.Clayey Silt w/shells													0.01
KE-16	0.0-3.2	36.9	Org.Clayey Silt w/shells													0.01
NEWPORT SPOIL AREA																
KE-1A	0.0-4.5	110	Layered, Clay, Silt & Sand w/shells	102.7	1.644	67.6	1.083	2.671	6.6	2.18	0.05	1.07	0.27	0.08	13.7	0.09
KE-2A	0.0-1.0	110	Silty fine sand w/shells	117.2	1.88	93.9	1.51	2.667	7.0	0.75	0.06	0.46	0.08	0.05	9.2	0.06
KE-3A	0.0-3.5	108	Silty fine sand w/shells	121.0	1.94	99.3	1.59		6.8	0.82	0.04	0.15	0.05	0.09	1.6	0.06
KE-4A	0.0-4.0	105	Fine sandy silt w/shells	115.4	1.85	91.0	1.46		7.0	1.27	0.05	0.38	0.11	0.07	5.4	0.07

SAMPLES TAKEN USING MODIFIED KULLENBERG CORER (1970-71)

FALL RIVER HARBOR, MASS.

TEST RESULTS

Explor. No.	Depth Range (ft.)	Elev. Below MLW	Wet Unit Weight pcf	Wet Unit Weight gm/cc	Dry Unit Weight pcf	Dry Unit Weight gm/cc	Apparent Sp. Gr.	Volatile Solids (%)	C (%)	H (%)	N (%)	C/N	Hexane Soluble (%)
K-3	0.0-5.0	40.5	86.0	1.378	44.62	0.715	2.50	8.14	3.69	0.63	<0.05	<73.8	0.13
K-12	0.0-4.8	38.2	84.09	1.346	44.36	0.710	2.57	6.97					
K-19	0.0-3.4	31.6	57.15	0.915	23.60	0.378	2.49	10.54					
K-27	0.0-4.6	34.2	67.23	1.077	32.02	0.513	2.54	9.97					
K-42	0.0-5.0	39.2	86.39	1.384	45.54	0.729	2.52	7.26	1.68	0.19	<0.05	<33.6	0.23
K-52	0.0-5.0	39.2	78.97	1.265	38.89	0.623	2.57	7.40					
K-56	0.0-5.0	37.7	79.14	1.268	38.72	0.620	2.58	6.48					
K-60	0.0-5.0	38.2	90.04	1.443	50.09	0.803	2.57	5.65					
K-61	0.0-5.0	39.2	90.23	1.446	49.56	0.794	2.66	5.41	1.37	0.26	<0.05	<27.4	0.15
K-65	0.0-3.2	36.6	83.37	1.336	45.46	0.729	2.66	5.17					
K-68	0.0-3.2	37.3	69.58	1.115	37.08	0.594	2.60	6.13					
K-73	0.0-5.0	38.3	79.37	1.272	42.55	0.682	2.66	6.71					
K-83	0.0-5.0	38.3	84.32	1.351	47.71	0.764	2.58	4.80	1.95	0.18	<0.05	<39.0	0.17
K-89	0.0-5.0	36.1	89.12	1.428	55.42	0.888	2.54	4.30					
K-93	0.0-5.0	35.9	81.86	1.309	37.71	0.604	2.50	7.37					
K-101	0.0-2.0	36.2	56.95	0.913	26.17	0.420	2.53	7.27					
K-105	0.0-3.6	34.5	66.17	1.059	32.78	0.525	2.59	5.62	1.59	0.17	<0.05	<31.8	0.10

FALL RIVER HARBOR, MASS. - R. I.

TEST RESULTS (1970-71)

EXPLOR. NO.	ELEV. BELOW MLW (FT)	MPN FECAL COLIFORM	BOD	BIOASSAY
KE-1	40.3	Plating methods showed	1.94	All fish survived
KE-6	38.7	no evidence of fecal	2.35	All fish survived
KE-11	38.4	coliforms in dilutions	2.25	All fish survived
KE-12	38.2	of 1:100 and 1:1000.	2.35	All fish survived
KE-14	39.0	Thus there were < 100	2.57	All fish survived
KE-16	36.4	fecal coliforms per gram of sample	1.73	All fish survived
NEWPORT SPOIL AREA		MPM determinations showed high numbers		
KE-1	110	of total coliforms, but	2.61	All fish survived
KE-2	110	none of these were	2.61	All fish survived
KE-3	108	confirmed as fecal	2.36	All fish survived
KE-4	105	in origin	1.98	All fish survived

BOD ANALYSIS - All BOD values are based on the average of duplicate samples and expressed as mg O_2/l/0.5 gm of sediment/5 days

BIOASSAY - A dilution series containing 10%, 1% and 0.1% of the sediment was prepared in sea water (30.00 $o/_{oo}$) for the following three combined samples: KE-1, 2, 3 & 4 (Newport Spoil Area, R.I.). KE-1, 6 & 16 (Fall River Harbor, Mass. - R. I.) and KE-11, 12 & 14 (Fall River Harbor, Mass. - R. I. No death was observed in all experimental and control groups in 4 days.

FALL RIVER HARBOR, MASS.

Test Results

Explor. No.	*Hg % x10^{-4}	+Hg % x10^{-4}	*Cr % x10^{-3}	+Cr % x10^{-3}	*Cu % x10^{-4}	+Cu % x10^{-4}	*Zn % x10^{-3}	+Zn % x10^{-3}	*Pb % x10^{-3}	+Pb % x10^{-3}	+Ag % x10^{-5}	*Cd % x10^{-5}	+Cd % x10^{-5}	*Sn % x10^{-4}	+Sn % x10^{-4}	*Bi % x10^{-4}	+Bi % x10^{-4}	*As % x10^{-4}	+As % x10^{-4}	*I % x10^{-5}	+I % x10^{-5}
KE-1	0.011	0.019	1.48	2.57	5.4	9.4	3.4	5.92	0.67	1.16	4.3	1.0	1.7	<3.0	<5.2	<3.0	<5.2	4.7	8.18	<2.0	<3.5
KE-2	0.0079	0.0137																4.5	7.83		
KE-3	0.140	0.241	1.75	3.01	8.8	15.1	4.0.	6.88	1.15	1.98	5.2	<1.0	<1.7	<3.0	<5.2	<3.0	<5.2	6.55		<2.0	<3.4
KE-4	0.011	0.0191																4.8	11.27		
KE-6	0.12	0.209	1.75	3.04	7.4	12.9	4.2	7.31	1.0	1.74	6.1	<1.0	<1.7	<3.0	<5.2	<3.0	<5.2	5.3	9.20	<2.0	<3.5
KE-8	0.52	0.90																5.15	8.96		
KE-9	0.011	0.019																3.4	5.92		
KE-10	0.036	0.064	1.55	2.77	5.8	10.4	3.65	6.53	7.5	1.34	1.8	1.0	1.8	<3.0	<5.4	<3.0	<5.4	6.65	11.90	<2.0	<3.6
KE-12	1.47	2.56																5.3	9.22		
KE-13	0.062	0.108	2.35	4.09	10.8	18.8	4.75	8.26	2.35	4.09	5.2	<1.0	<1.7	<3.0	<5.2	<3.0	<5.2	4.2	7.31	<2.0	<3.5
KE-14	0.041	0.071	1.50	2.61	4.5	7.8	3.25	5.65	0.70	1.22	10.4	1.0	1.7	<3.0	<5.2	<3.0	<5.2	6.9	12.0	<2.0	<3.5
KE-16	0.067	0.116																3.75	6.52		
NEWPORT SPOIL AREA																					
KE-1A	0.041	0.062	1.8	2.73	15.8	24.0	4.2	6.37	1.02	1.55	7.0	2.5	3.8	<3.0	<4.5	<3.0	<4.5	4.53	6.91	<0.2	<0.3
KE-2A	0.014	0.024	0.65	1.13	4.7	8.1	2.8	4.87	0.47	0.81	1.7	16.0	28.0	<3.0	<5.2	<3.0	<5.2	4.60	7.98	<0.2	<0.3
KE-3A	0.017	0.021	1.0	1.22	4.5	5.5	1.95	2.38	0.65	0.79	2.4	<1.0	1.2	<3.0	<3.7	<3.0	<3.7	3.55	4.33	<0.2	<0.24
KE-4A	0.015	0.019	1.25	1.58	11.7	14.8	4.9	6.21	4.4	5.57	2.5	1.5	1.9	<3.0	<3.8	<3.0	<3.8	4.40	5.57	<0.2	<0.25

Testing performed using Atomic Absorption Spectrophotometer

*Conc. % (wet wgt basis)
+Conc. % (converted to dry wgt basis)

Samples taken using modified Kullenberg Corer (1970-71)

TAUNTON RIVER, MASS. (Above Fall River Harbor)
TEST RESULTS (1970-71)

Explor. No.	Sample Depth (Ft.)	Elev. Below MLW	CLASSIFICATION	*Hg % x10^{-4}	+Hg % x10^{-4}	*As % x10^{-4}	+As % x10^{-4}
G-2	0.0 - 0.3	15.9	Dk gray sandy organic silt w/shells & vegetation	3.41	4.94	8.75	12.67
G-4	0.0 - 0.3	26.3	Dk gray sandy organic silt w/shells & vegetation	2.42	3.51	14.90	21.60
G-6	0.0 - 0.3	24.4	Dk gray sandy organic silt w/numerous shells	3.10	4.50	12.60	18.27
G-8	0.0 - 0.3	29.6	Organic silty sand w/shells & vegetation	5.15	7.47	11.90	17.25
G-10	0.0 - 0.3	28.5	Vegetation w/silt, sand & shells	2.45	3.55	8.20	11.89
P-2	0.0 - 1.5	10.5	Dk gray sandy silt, w/shells & vegetation	1.92	3.05	11.90	17.81
P-4	0.0 - 1.5	8.5	Gray-brown, sandy silt w/trace of shells & vegetation	0.21	0.33	5.50	8.74
P-5	0.0 - 1.2	6.9	Gray-brown, sandy silt w/trace of shells & vegetation	1.26	2.00	7.65	12.16
P-9	0.0 - 1.4	5.6	Gray brown silt to 0.7'. Brown M-F sand to 1.4'	0.12	0.15	2.95	3.76
P-10	0.0 - 1.5	7.0	Black muck w/silt, sand, shells & vegetation	2.87	4.10	15.40	22.02

* Conc. % (wet wet basis)
+ Conc. % (converted to dry weight basis)
EXPLORATION METHOD G- Petersen Dredge
P- Plastic core

(Sample Locations - Newport spoil K-1A, K-4A
Fall River Harbor K-3, K-13)

ANALYSIS

The samples were analyzed for Chlordane, Dieldrin, Toxaphene, Parathion, Malathion, and DDT and its analogs.*

In addition, the samples were analyzed for the following:

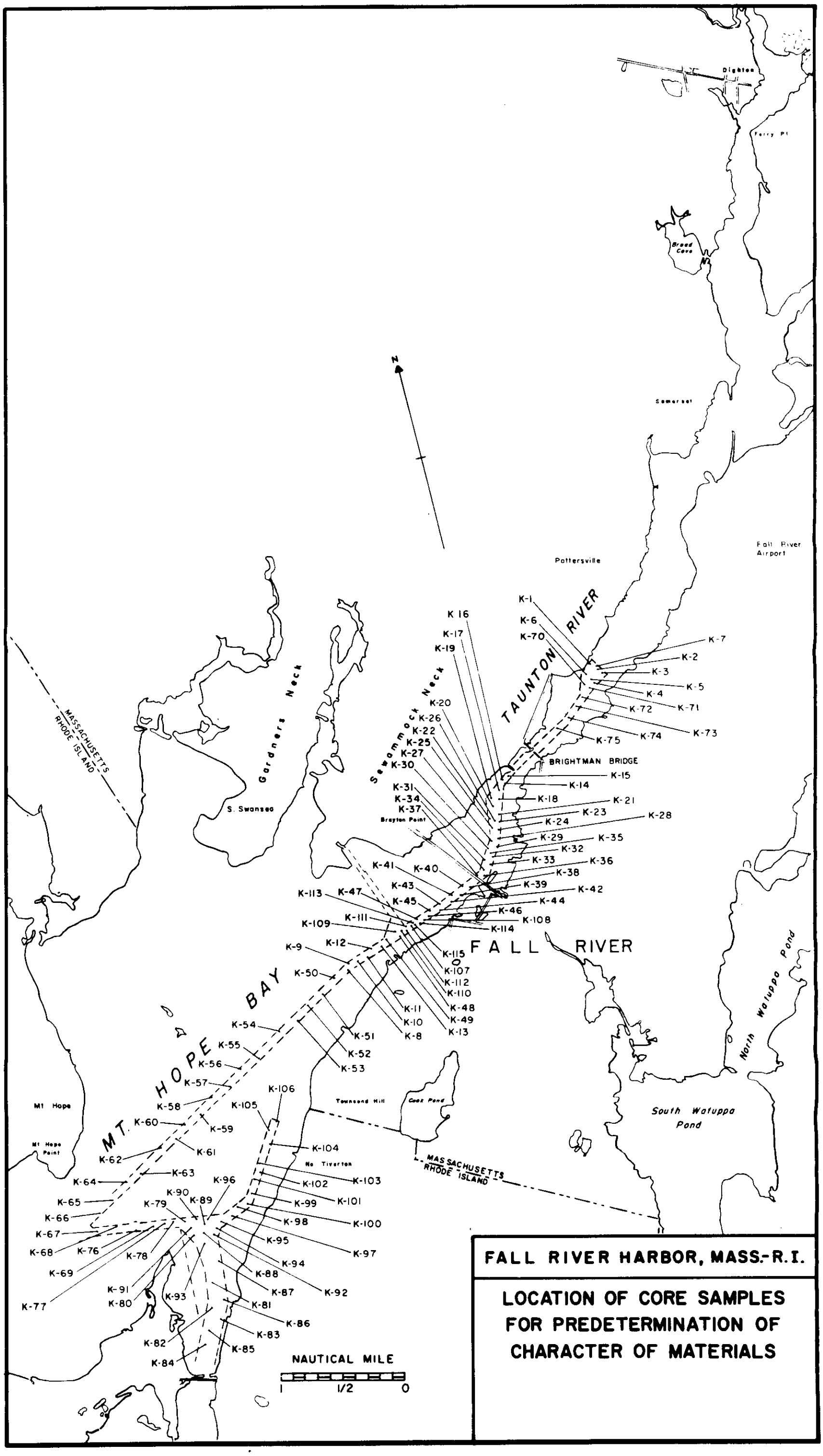
Chlorinated Hydrocarbon Pesticides	Organophosphate Pesticides
Lindane	Methyl Parathion
A-BHC	Dursban
B-BHC	Guthion
Kelthane	Fenthion (Baytex)
Endosulfan	Bidrin
Heptachlor	Diazinon
Heptachlor Epoxide	Dibrom (Naled)
Aldrin	
Endrin	
Methoxychlor	
Strobane	
Bandane	

The sensitivity of the analysis was one part per billion. The percent recovery was 98%. A blank sample was included in the analysis to insure that the samples would be free of contamination.

RESULTS

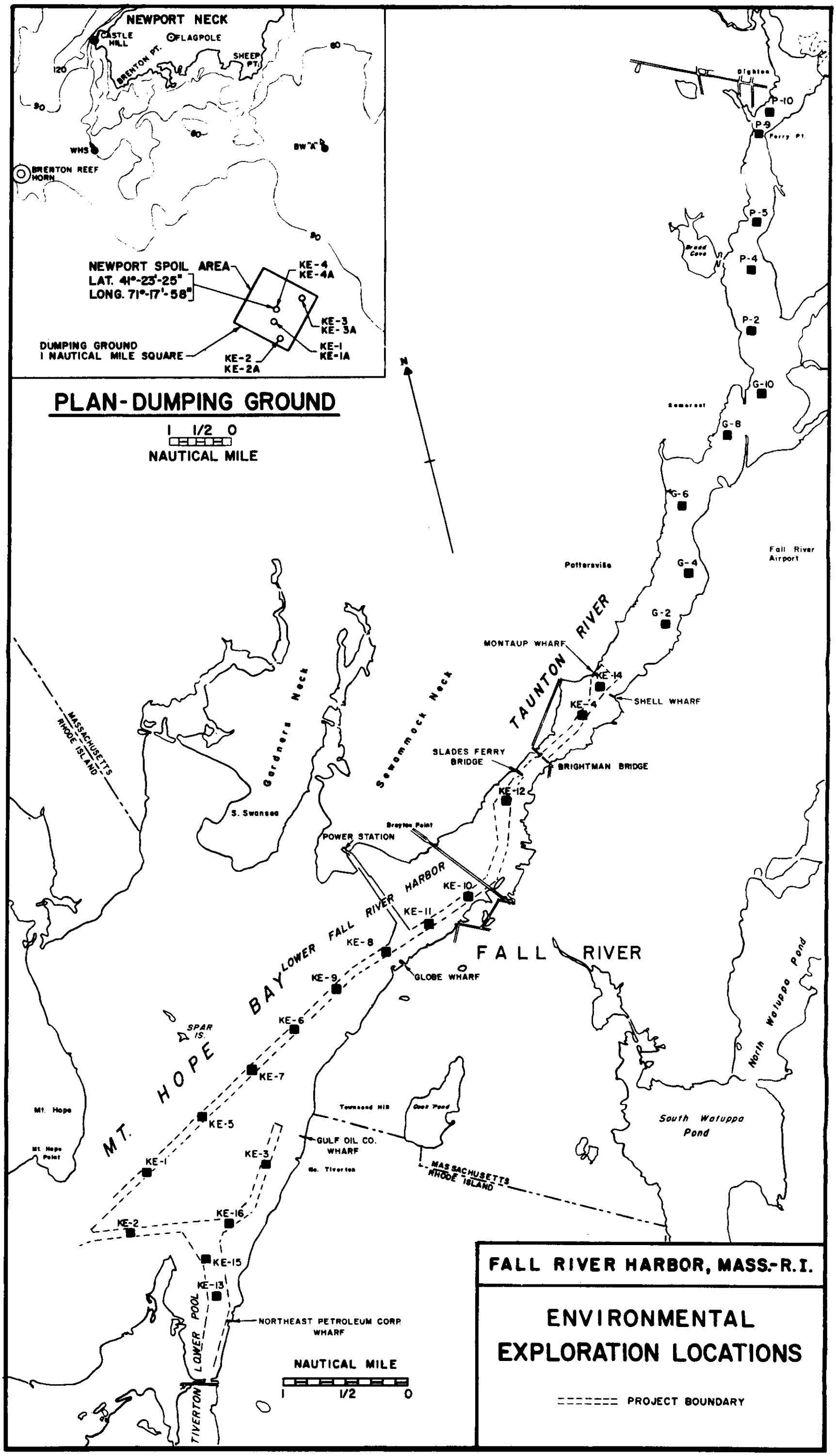
Qualitative and quantitative analysis proved that there was no detectable pesticides or polychlorinated biphenyls in the four mud samples.

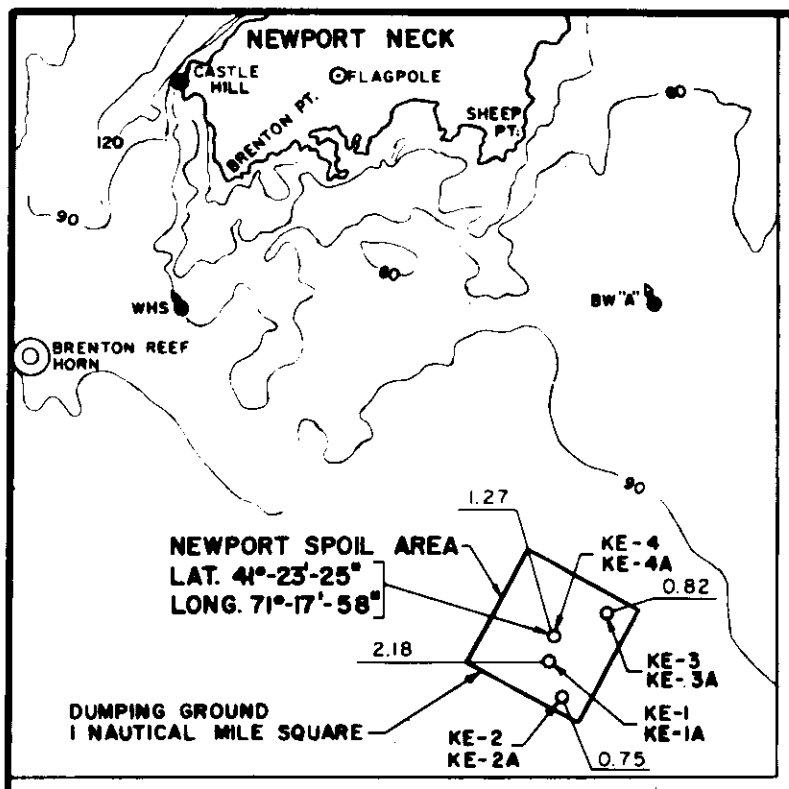
*DDT and its analogs: p,p'-DDT; o,p'DDT; p,p'DDE; o,p'DDE; p,p'DDD; o,p'-DDD; DDA; DCBP; DDMU.



FALL RIVER HARBOR, MASS.-R.I.

LOCATION OF CORE SAMPLES FOR PREDETERMINATION OF CHARACTER OF MATERIALS

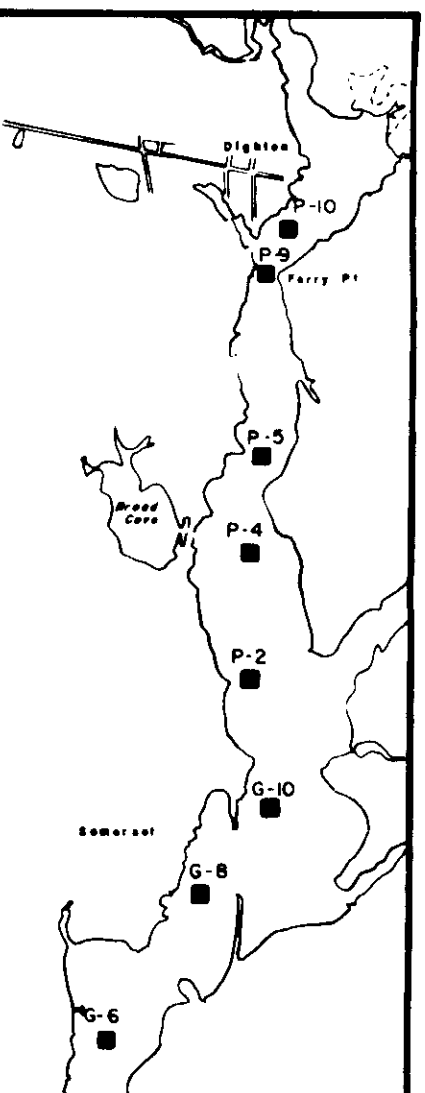

NEWPORT NECK
CASTLE HILL
FLAGPOLE
BRENTON PT.
SHEEP PT.
120
90
80
WHS
BW "A"
BRENTON REEF HORN
NEWPORT SPOIL AREA
LAT. 41°-23'-25"
LONG. 71°-17'-58"
KE-4
KE-4A
KE-3
KE-3A
KE-1
KE-1A
KE-2
KE-2A
DUMPING GROUND
1 NAUTICAL MILE SQUARE
PLAN-DUMPING GROUND
1 1/2 0
NAUTICAL MILE
N
Bristol
P-10
P-9
Ferry Pt.
P-5
Broad Cove
P-4
P-2
G-10
Somerset
G-8
G-6
G-4
G-2
Fall River Airport
Pottersville
TAUNTON RIVER
MONTAUP WHARF
KE-14
KE-4
SHELL WHARF
SLADES FERRY BRIDGE
BRIGHTMAN BRIDGE
KE-12
Gardners Neck
Sawmmock Neck
MASSACHUSETTS
RHODE ISLAND
S. Swansea
Brayton Point
POWER STATION
KE-10
KE-11
KE-8
KE-9
KE-6
KE-7
KE-5
KE-3
KE-1
KE-2
KE-16
KE-15
KE-13
BAY
LOWER FALL RIVER HARBOR
FALL RIVER
GLOBE WHARF
SPAR IS.
MT. HOPE
Mt. Hope
Mt. Hope Point
Townsend Hill
Goat Pond
GULF OIL CO. WHARF
No. Tiverton
NORTHEAST PETROLEUM CORP. WHARF
LOWER POOL
TIVERTON
South Watuppa Pond
North Watuppa Pond
NAUTICAL MILE
1 1/2 0
FALL RIVER HARBOR, MASS.-R.I.
ENVIRONMENTAL EXPLORATION LOCATIONS
PROJECT BOUNDARY

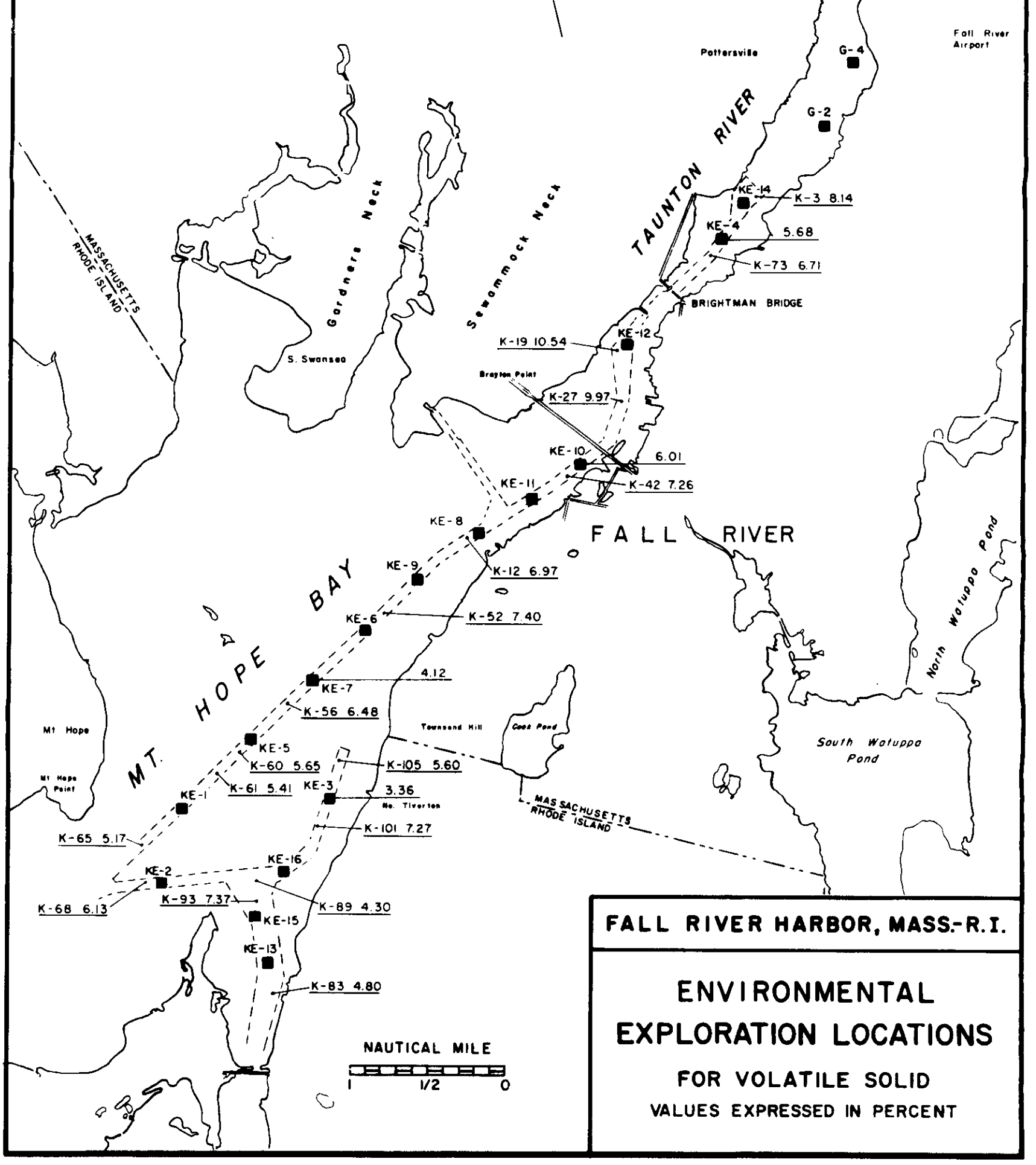


PLAN-DUMPING GROUND

1 1/2 0
NAUTICAL MILE

N



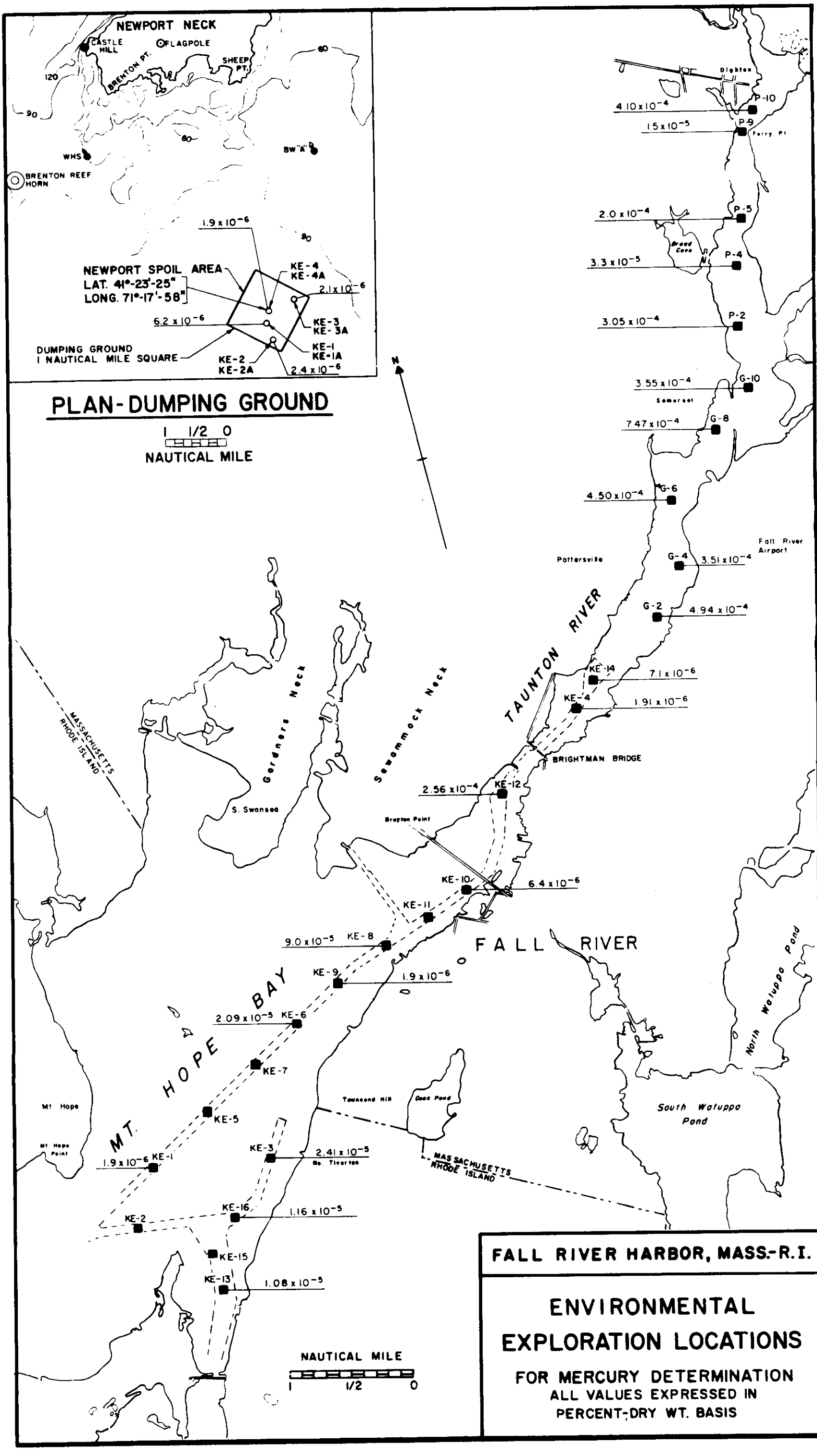


FALL RIVER HARBOR, MASS.-R.I.

ENVIRONMENTAL EXPLORATION LOCATIONS

FOR VOLATILE SOLID

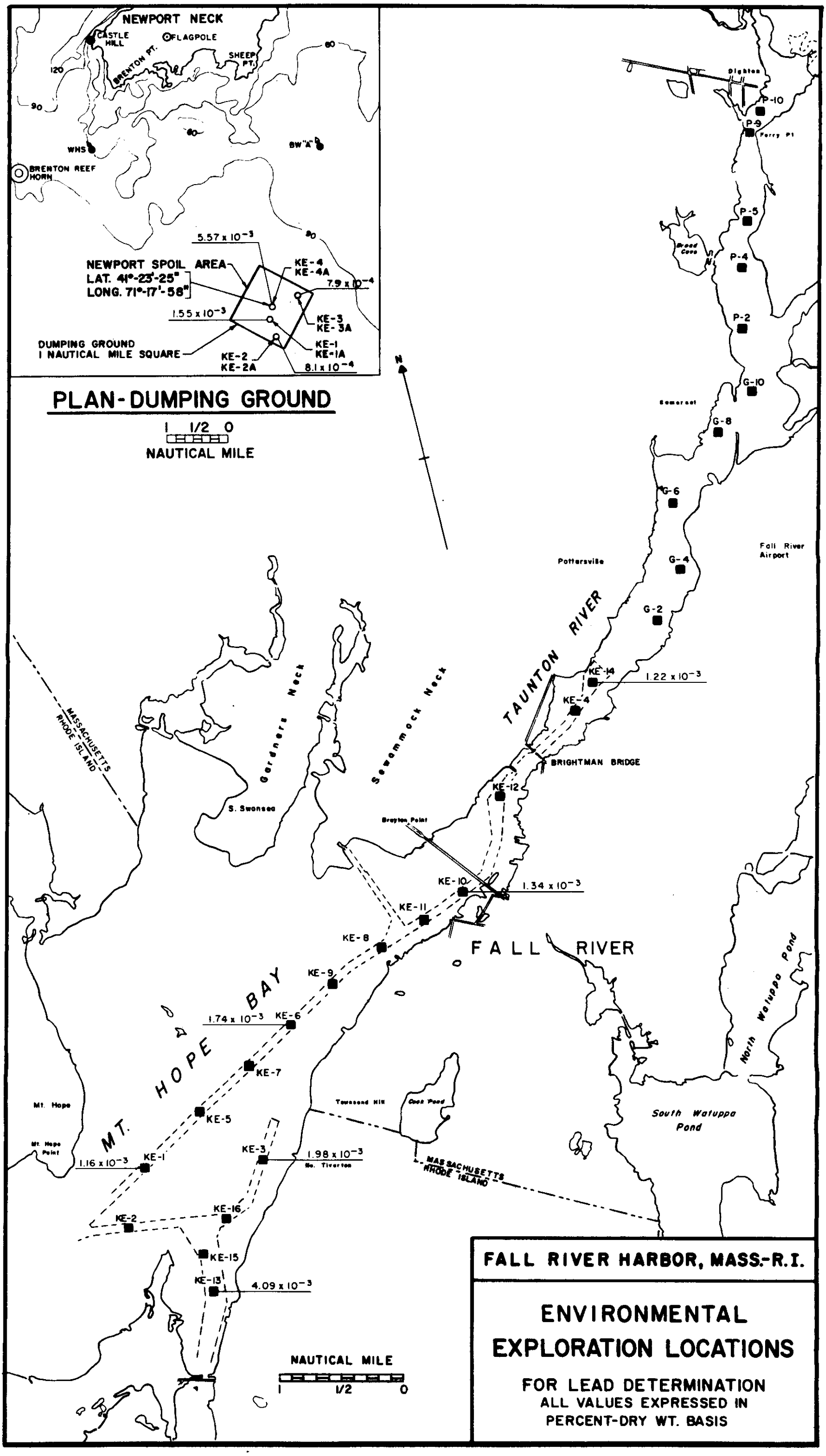
VALUES EXPRESSED IN PERCENT

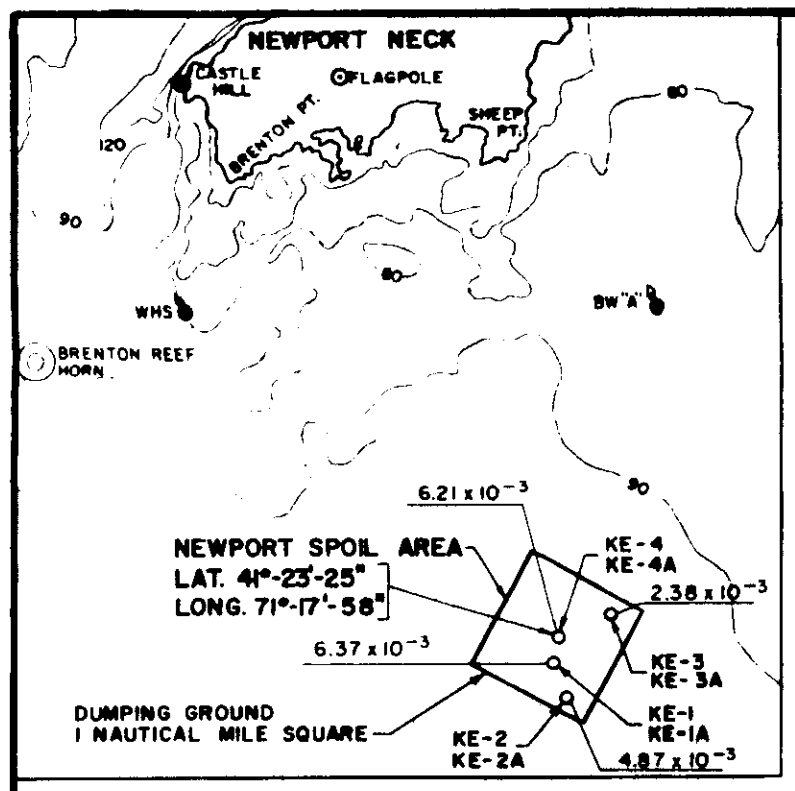


FALL RIVER HARBOR, MASS.-R.I.

ENVIRONMENTAL EXPLORATION LOCATIONS

FOR MERCURY DETERMINATION
ALL VALUES EXPRESSED IN
PERCENT-DRY WT. BASIS


NEWPORT NECK
CASTLE HILL
FLAGPOLE
BRENTON PT.
SHEEP PT.
120
90
60
60
80
WHS
BW "A"
BRENTON REEF HORN
5.57 x 10⁻³
NEWPORT SPOIL AREA
LAT. 41°-23'-25"
LONG. 71°-17'-58"
KE-4
KE-4A
7.9 x 10⁻⁴
1.55 x 10⁻³
KE-3
KE-3A
DUMPING GROUND
1 NAUTICAL MILE SQUARE
KE-1
KE-1A
KE-2
KE-2A
8.1 x 10⁻⁴
PLAN-DUMPING GROUND
1 1/2 0
NAUTICAL MILE
N
Dighton
P-10
P-9
Ferry Pt
P-5
Broad Cove
P-4
P-2
G-10
Somerset
G-8
G-6
G-4
G-2
Fall River Airport
Pottersville
TAUNTON RIVER
KE-14
1.22 x 10⁻³
KE-4
BRIGHTMAN BRIDGE
KE-12
Brayton Point
KE-10
1.34 x 10⁻³
KE-11
KE-8
KE-9
FALL RIVER
1.74 x 10⁻³
KE-6
KE-7
KE-5
MT. HOPE BAY
Mt. Hope
Mt. Hope Point
1.16 x 10⁻³
KE-1
KE-3
1.98 x 10⁻³
So. Tiverton
KE-16
KE-2
KE-15
KE-13
4.09 x 10⁻³
Townsend Hill
Cook Pond
MASSACHUSETTS
RHODE ISLAND
North Watuppa Pond
South Watuppa Pond
Gardners Neck
Sawmmock Neck
S. Swansea
MASSACHUSETTS
RHODE ISLAND
NAUTICAL MILE
1 1/2 0
FALL RIVER HARBOR, MASS.-R.I.
ENVIRONMENTAL EXPLORATION LOCATIONS
FOR LEAD DETERMINATION
ALL VALUES EXPRESSED IN PERCENT-DRY WT. BASIS



PLAN-DUMPING GROUND

1 1/2 0

NAUTICAL MILE

FALL RIVER HARBOR, MASS.-R.I.

ENVIRONMENTAL EXPLORATION LOCATIONS

FOR ZINC DETERMINATION

ALL VALUES EXPRESSED IN PERCENT-DRY WT. BASIS